Engineering Library
AUG 8 1921

IN TWO SECTIONS—SECTION ONE

MECHANICAL ENGINEERING

INCLUDING THE ENGINEERING INDEX

IN THIS NUMBER

INDUSTRY'S SUPPLY OF ENERGY
By Dr. George Otis Smith, Director United States Geographical Survey

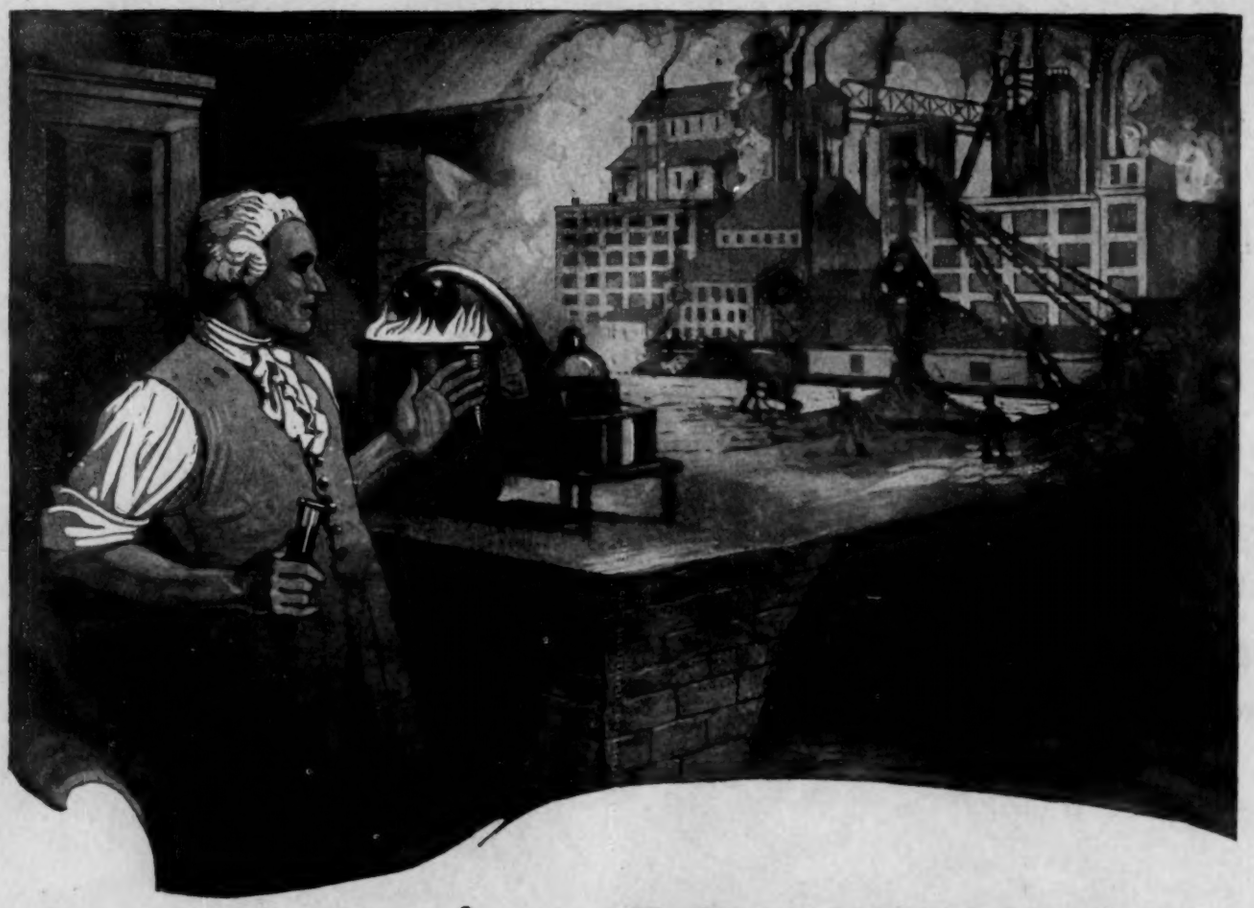
THE DEVELOPMENT OF ARTILLERY MATERIEL
By Major G. F. Jenks, Ordnance Department, United States Army

CLOTHS FOR MECHANICAL USES
By James W. Cox, Jr., Textile Engineer

MEETING OF THE FEDERATED AMERICAN ENGINEERING SOCIETIES
L. W. Wallace Elected Secretary—Address by Herbert Hoover on Industrial Waste

MARCH 1921

THE MONTHLY JOURNAL PUBLISHED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS



γεννάω–I Produce!

ONE hundred and forty-four years ago Lavoisier coined the name *Oxygen.*

In choosing the Greek word Γεννάω "I produce," as his main root he had in mind a chemical reaction commonly associated with the gas.

Had Lavoisier been able to foresee the tremendous part that Linde Oxygen is playing in modern industrial development, he would have realized the vast significance of that word Γεννάω "I produce!"

The country over, Linde Oxygen is daily making possible greater production—everywhere it is saving time and cutting costs.

A chain of seventy-five Linde plants and warehouses assures American welders and cutters of a prompt supply of highly pure oxygen—wherever they are, whatever their requirements.

THE LINDE AIR PRODUCTS COMPANY

Carbide and Carbon Building, 30 East 42nd Street, N. Y.

Kohl Building, San Francisco

The Largest Producer of Oxygen in the World

L-503-21

Mechanical Engineering

The Monthly Journal Published by

The American Society of Mechanical Engineers

Publication Office, 207 Church Street, Easton, Pa. Editorial and Advertising Departments at the Headquarters of the Society, 29 West Thirty-ninth Street, New York

VOLUME 43 MARCH, 1921 NUMBER 3

TABLE OF CONTENTS

Industry's Supply of Energy, G. O. Smith 165
The Development of Artillery Materiel, G. F. Jenks 167
Cylindrical Grinding in 1920, W. H. Chapman 173
Cloths for Mechanical Uses, J. W. Cox, Jr. 177
Phases of the Transportation Problem 181
- Motor-Truck Transportation, F. W. Davis 181
- The Government and Inland Waterways, F. T. Hines 181
- Transportation and Terminal Problem of New York as Affected by the Hudson River, G. Lindenthal 182
- Transportation, J. R. Bibbins 183

Test Code for Evaporating Apparatus 184
Survey of Engineering Progress 189
- Recent Trend in Locomotive Design in Europe—Comparison of Theories of Elongation and of Shear Stress—Short Abstracts of the Month.

Engineering Research 204
Correspondence 206
Work of the A.S.M.E. Boiler Code Committee 210
Plans for Organizing the Port of New York 211
Editorial Notes 212
- Recent Hydraulic Development on the Pacific Coast—Labor as a Business, Not a Commodity—National Board of Boiler and Pressure Vessel Inspectors—Steam-Turbine Locomotive—Rankine the Man—Industrial Disputes in Canada.

News of Other Societies 215
John Fritz Medal Awarded to Sir Robert A. Hadfield 215
Marine Electrical Engineering 216
L. W. Wallace Secretary of F.A.E.S. 217
Address on Industrial Waste by Herbert Hoover 217
Engineering and Industrial Standardization 218
Library Notes and Book Reviews 219
Engineering Index 221
A.S.M.E. Affairs (Section Two) 29–40
Advertising Section:
- Display Advertisements 231–EI
- Classified Advertisements 109
- Consulting Engineers 110
- Classified List of Mechanical Equipment 116
- Alphabetical List of Advertisers 134

Price 50 Cents a Copy, $4.00 a Year; to Members and Affiliates, 40 Cents a Copy, $3.00 a Year. Postage to Canada, 50 Cents Additional; to Foreign Countries, $1.00 Additional.

Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879.
Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized on January 17, 1921.
C 55. The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

Contributors and Contributions

57,000 : 9.25 = Coal Supply : Oil Supply

Many statistics have been published on the world's fuel supply, but they have been proverbially "dry" for the reader and beyond his power to visualize because of the magnitude of the units involved. Not so with the data which Dr. George Otis Smith, Director of the U. S. Geological Survey, has given on this subject in the leading article of this number. Nothing could be more entertaining than his story of the application of mechanical power to the human worker, and nothing more lucid than his statement of the allotment of fuel which, in consequence, must be made to every inhabitant of our country. It is not often that the facts relating to "black rock" and "coal oil" are so interestingly and dramatically put together as in this article in dealing with the diminution of our fuel reserves. Dr. Smith's ratio of 57,000 to 9.25 as the relative amounts of available coal and oil is one easy to remember and of great import to the users of fuel. Dr. Smith has served as Director of the Geological Survey since 1907 and has been in geological work since 1893.

Underwood & Underwood

GEORGE OTIS SMITH

Ordnance Development Independent of Size of Army

Regardless of the general belief as to the size of the United States Army, ordnance development must be pursued aggressively to assure preparedness in ideas that will stand at the forefront. Artillery and ordnance in blueprint form cannot be destructively effective. A broad understanding of ordnance requirements by manufacturers of the country is vital to the successful translation of blueprints to shells. With this in mind Major Jenks, of the Ordnance Department, U. S. A., presented a paper before the Washington Section in which the progress of artillery development of the United States is outlined. Major Jenks, detailed to the ordnance service from the coast artillery, occupied an important position in the production of artillery during the war and at present is engaged in the development of the artillery program.

Grinding of Today

Grinding as a production process, rather than as a finishing process, simply is at the threshold of its development. Mr. Chapman, who outlines some of the recent advances in the directions of greater economy and increased output in this issue, is a Cornell graduate of the class of 1913. He has served on the research staff of the Norton Company, engaged in the development of the principles of grinding, since 1916, with the exception of about a year when as first lieutenant in the Ordnance Department he served as Commanding Officer at the Aircraft Armament Factory of the A. E. F. at Courbevoie-Seine.

Cloths for Mechanical Uses

The fact that cloth is coming into extensive use for mechanical purposes as a substitute for leather, metal binding, rawhide, sheet metal, wire screens, etc., led the Textile Section of the A.S.M.E. to arrange for a paper describing these many uses. This paper was prepared by James W. Cox, Jr., Textile Engineer, of New York, and shows how vital the accomplishments of the textile industry now are in many branches of engineering and manufacturing. The paper is published in full in this issue.

Consistent Results in Testing

How many readers appreciate the scope and tremendous importance of the work now in process by the A.S.M.E. Power Test Committees? With a main committee of 29 members, and an equal number of subcommittees of five or more members each, engaged in formulating testing codes for different types of prime movers and auxiliary apparatus, the undertaking is assuming vast proportions. Its purpose is to bring about standard methods of testing so that the results of tests made by different observers in different localities will be comparable. These codes as tentatively developed will be published from time to time in MECHANICAL ENGINEERING. This number contains the code on evaporating apparatus.

Water Power on the Pacific Coast

The need of power development in the Far West, and particularly on the Pacific Slope, in order to keep pace with the agricultural and industrial growth, has become acute. Attention is naturally directed to water power and the signed editorial in this issue, by Robert Sibley, outlines the great plans projected for the use of white coal on the West Coast. Mr. Sibley's enthusiastic talk on this subject before the Local Sections delegates at the Annual Meeting will long be remembered by those in attendance. Mr. Sibley is the editor of the *Journal of Electricity and Western Industry*, and has recently been elected president of the McGraw-Hill Company of California. The main thought guiding his editorial and technical work is the desire to assist in developing the vast water-power resources west of the Rocky Mountains and to bring about the commercial and industrial supremacy of the West.

Plans for A.S.M.E. Spring Meeting

Congress Hotel, Chicago, May 23-26

Program will include session on Problems of Chicago as a Rail-Water Gateway, session on Industrial Education, and well-developed technical meetings arranged by Professional Sections on Forest Products, Fuels, Machine Shop, Management, Materials Handling, Power and Railroads. Related excursions to be provided.

Meeting will adjourn to Rock Island Arsenal Friday, May 27, for session under auspices of Ordnance Section.

MECHANICAL ENGINEERING

Volume 43 March, 1921 Number 3

Industry's Supply of Energy

A Survey of the Available Supplies of Coal, Oil, and Water, Together with a Discussion of the Engineer's Part in the Economic and Efficient Utilization of Energy Units

By GEORGE OTIS SMITH,[1] WASHINGTON, D. C.

EDWARD EVERETT HALE charted the course of industrial development when he said that the extent to which the world had changed the laborer who uses his body into the workman who uses his head was the index of civilization. That distinction between laborer and workman is the contrast between the old and the new order. The formula for modern industry is man plus mechanical energy, or, better expressed, it is man multiplied by his machines. The true measure of industrial progress is found in the amount of mechanical power used to supplement man power. As mechanical engineers you may have been so devoted to the task of perfecting the application of power to man's use that you have had little time to think of the sources of the energy you use or to estimate the supply of energy available. The present scope and future possibilities of your profession take on larger dimensions if we survey the whole field and so appreciate better its vast extent. As I see the task of the mechanical engineer, he is the guide who best knows the routes by which mankind must travel in order to take full possession of the stores of energy that await utilization.

For contrast with the present era of machine-aided civilization we naturally turn to the days of ancient Rome or Greece or Egypt, when hordes of slaves toiled both in the erection of those great monuments that have been called the "wonders of the world" and in the performance of the daily tasks of providing the necessities and luxuries of that age. Man power then made use of only the simplest laws of mechanics. Far less depressing is it to go still further afield and recall those tales of the Arabian Nights wherein the slaves of the lamp performed their work with the ease and dispatch that accords more nearly with the methods of today. To what extent is it granted to us of this day and generation to rub the modern Aladdin's lamp and summon the genii to do our bidding? How many servants have we working for us?

I find that several writers on the subject of power have estimated the number of energy servants in our employ, and these estimates are based upon the installed capacity of our prime movers, which is approximately 100 million horsepower, or nearly one horsepower to each man, woman, and child in the United States. Using the equivalent of ten man-power hours to the horsepower-hour we find in this the suggestion that we each have the equivalent of ten servants to do our bidding. But even mechanical power has some of the frailties of human power: capacity and performance are rarely equal. So, if we take the statistics of the energy output that we really utilize we discover that these energy servants work very short days, for, with the exception of the electric utilities, our prime movers do not give us anything like the equivalent of an 8-hour day in terms of their rated capacity. The steam locomotives, which represent perhaps 60 per cent of the total installed capacity, average only about a 7 per cent use factor, which brings down the average load factor to not much over 14 per cent.

These workers, represented by the water turbine and the steam engine, are tireless, it is true, and they are able to render continuous service as man power cannot, yet the fact is that we do not so use them. We may figure that we each have ten energy servants to help us in the world's work, but as they average only about 23½ hours a week a better statement would be that we each of us have the equivalent of five slaves working for us day by day. You will note that this estimate is arrived at by figuring that with a 14 per cent load factor it takes nearly two installed horsepower to equal one continuous horsepower for the human week of 44 hours. This quota of five energy servants for each of us is far in excess of what the Greeks possessed in the form of human slaves, five helots being, I understand, the power equipment of the average Greek freedman's family, or nearer one apiece, when Greek culture rested on a substratum of slave labor.

The census of our energy slaves I have just taken does not include the millions of automotive engines in our pleasure cars, trucks and tractors, which may in rated capacity far exceed that of the prime movers I have mentioned. Yet it might be difficult to figure the load factor of these engines and so to calculate in horsepower the service they render to us. Horsepower is indeed the appropriate measure of the work these automotive engines perform, as they are substitutes for the horses on our city streets, on our interurban highways, and more and more on our farms. With an average of one automobile car or truck to every two or three families the contrast is great between our civilization and that of the ancients, in which long lines of slaves carried on their backs the wealth of that day. Indeed, we have only to go to the Orient of today to see man labor in its simple terms, with little of the multiplication by machinery that characterizes our Occidental world.

In contrast, then, with the Greek civilization of the past or even with Oriental life of today is daily life and work as we know it, and we can clearly see that the Anglo-Saxon dominance of industry and commerce is founded largely on coal and iron. It was the steam engine that gave birth to modern industrialism and to modern distribution of the products of industrialism. The centralization of power units, which took place nearly half a century earlier in England than in the United States, resulted in the centralization of industry in factory towns and put large plants in the place of small workshops and home looms. So the industrial change in the century just past was greater than in all the earlier centuries recorded in history. Indeed, the development of industry was so rapid that the industrial scheme changed more in a few years than it had in the 18 centuries since the boy Jesus worked at the carpenter's bench in his father's shop. All this is only the story of the application of mechanical power to the aid of the human worker.

Present Supply of Energy and Its Distribution

The estimates I have already used for last year's utilization of power give a good starting point for our review of the present and future supply of energy. The engineers who are making the special power investigation under the United States Geological Survey figure 125 billion horsepower-hours as last year's output in the United States. Of this total of primary power more than 82 per cent is credited to steam, a little over 15 per cent to water, and the remainder—less than 3 per cent—to internal-combustion engines. As to the uses, the division of this power is, roughly, public utilities 42 per cent; manufacturing industries, not including rented electric power, 28 per cent; and steam railroads, 30 per cent. The statistical basis for these estimates is not all that we might wish, but they show roughly where the energy we use comes from and what we use it for.

---

[1] Director, United States Geological Survey.

Paper presented at the Fortieth Anniversary meeting of The American Society of Mechanical Engineers held by the Chicago Section at Chicago, Ill., November 22, 1920.

Much of the work that is done for us by these servants is done so far away that we are unconscious of what it involves. At least four of the five slaves in whose work each of us can claim the larger share owe their strength to coal; their power is that of the steam engine turning this wheel and that wheel the country over. Here in the United States our per capita consumption of coal exceeds that of any other country, and we ourselves may sometimes wonder what becomes of the annual 6 tons or more allotted to each man, woman and child. You and I well appreciate how many tons of coal we buy each year for our own household use, but we can only guess in a general way where the rest goes—to the railroads and furnaces and factories. Recently, in speaking to some steel men, I stated the facts of coal distribution somewhat as follows:

The figures of our coal resources, millions of millions of tons, or even the few hundred million tons of our annual output, are too large to be grasped, and it becomes necessary to express the facts in smaller quantities. Roughly speaking, 1000 tons of coal is what a mine worker mines in a year—the measure of what he contributes to the world's work and well-being. This human measure of 1000 tons also has the advantage of being easily visualized as a short train load (20 cars) of coal on its way to serve the varied needs of the consumer, and in our brief review of the subject we may well note first what are these needs—the principal uses of coal, among which this unit of 1000 tons is divided. Broadly stated, the largest use of coal is in furnishing motive power and heat for our industries and public utilities, 350 tons out of every 1000 tons mined going to the boiler house of factory, mill, shop or power plant. But next to these 7 carloads of coal distributed throughout the country are 5 cars, or 250 tons of coal, that the railroads burn for their own use. The domestic demand for coal comes next, 165 tons out of each 1000 tons of anthracite and bituminous coal being used in the homes of the land for heating and cooking. The coke ovens take nearly as much as the homes, or 130 tons; and the rest of our miner's contribution includes the coal for export and bunker use, 60 tons; the 35 tons of coal used in operating the coal mines themselves, which of course does not make up a part of our train load; and the 10 tons that goes to the gas works.

Coming back for a moment to the personal service which we receive from coal through steam, I can perhaps illustrate how close home this service may come and how silently it may be rendered by reference to our electric lights—new only yesterday but commonplace today. Here in a special sense coal is the slave of the lamp. To learn how much coal comes into my house over the wire, I recently reviewed my electric-light bills and converted kilowatt-hours back into pounds of coal, with the result that I found that my household had used $1^1/_5$ tons of coal in a year simply to provide illumination. This annual per capita consumption of 400 pounds of coal for illumination is probably not far from an average figure, for even if my record is high in kilowatt-hours, the Washington central station is much lower in coal consumption than the average station. Nor do our coal requirements for illumination stop in our homes: in Washington, where our streets are far from being "white ways" at night, our street lighting, such as it is, with part electric and part gas lamps, costs each of us 33 pounds of coal and a gallon or two of gas oil each year. If we add to these figures something for the lighting in the buildings where we work, it probably costs each of us considerably more than a quarter of a ton of coal a year for our artificial light—to that extent are we drawing upon the sunshine of another geologic era.

To give perspective to our review of our present supply of energy, let us simply glance at our increasing use of coal. In 1918 we used nearly $6^1/_2$ tons per capita, but a century ago the country's output of perhaps 40,000 tons of coal amounted to less than 8 *pounds* per capita, or hardly more than is used in the central station to furnish my home with light for a single evening. Even fifty years ago when this country was on a coal basis, our per capita consumption had reached only about 1700 pounds, which would mean a real coal shortage today. This rate of increase in demand for coal alone does not make prophecy easy, yet in planning for the future you engineers should perhaps start off with an inventory of the world's supply of energy in the form of flowing water and the two mineral fuels, coal and oil, and, first of all, a glance at the way these are allotted to the continents.

The World's Sources of Energy

One of the by-products of the coöperative efforts by the Government scientific bureaus in aid of our Peace Commission was an inventory of the water-power resources of the world, and this is now being prepared for publication by the United States Geological Survey. It shows that only about one-twentieth of the potential power of the world's rivers has been utilized, and over half of this in North America, with Europe credited with one-third and the rest divided between Asia, South America, Oceanica, and Africa, in the order named. In its potential resources, however, Africa ranks not last but first; it has over 40 per cent of the world's supply of water power and is followed in turn by Asia, North America, South America, Europe and Oceanica.

In the division of coal resources among the continents, at least of the better grades of coal, similar inequalities are seen: North America has more than half, Asia about a quarter, Europe a sixth, and the rest is divided between Oceanica, Africa, and South America, in the order named.

The present realization of the world's interest in its supply of petroleum has led to similar estimates of the recoverable resources, first in the United States and then in other countries; and whether we dignify these quantitative measurements of oil reserve by terming them official estimates or describe them by calling them scientific guesses, they are the best we have, and they will serve fairly well in guiding national and international action.

It may be noted that the United States Geological Survey's estimate of the petroleum resources of the world shows that the distribution, while unevenly balanced among nations, is evenly balanced between the eastern and the western hemispheres, although the northern hemisphere appears to have at least five times as much oil as the southern. This preponderance of the oil supply of the northern hemisphere should, however, be discounted by a fact and a possibility; the land area of the northern hemisphere is three times that of the southern and the larger unexplored areas are in South America, Africa, and Oceanica.

Accepting the Stebinger-White distribution of the world's oil reserves, we may roughly set down the continents in order of wealth in oil in North America, Asia, South America, Europe, Oceanica, and Africa. In terms of regional distribution, more than half the world's oil reserves are believed to be concentrated in two intercontinental areas; one of these oil-rich provinces includes the North American and South American countries bordering the Caribbean Sea, and the other includes the countries of western Asia and southeastern Europe, with the Caucasus as an axis. On these two areas, then, each comprising only about 2 per cent of the earth's surface and each containing about 30 per cent of the world's future supply of oil, is focused the attention of the great nations that most need oil.

The resources of the world's oil shale are far too large to be lost sight of as a substitute source of oil. The United States alone is believed to possess deposits of oil shale that contain at least ten times as much oil as there is natural petroleum available in North America, but oil won by mining and distilling these shales, situated in the interior of a continent, cannot enter the world's markets as labor-cheap as the petroleum that flows from Mexican wells close to the coast. Such resources must therefore be regarded as a rear line of economic defense and as a source of power that will be of greater value to other generations than to this, even if a more general utilization of oil shales begins in the near future. No other continent is known to have resources of oil shale at all comparable with those of North America.

In this rapid review of the world's sources of energy we see North America taking first rank among the continents, with Asia a close second and Europe a poor third, although we should remember that Europe has a much smaller area than either of the other two.

Relative Importance of Coal, Oil and Water as Sources of Energy

Next, in considering how the world may best manage its ever-increasing power load, some aid may be found in a few comments on the differences between these three sources of energy—water, coal, and oil. Man has learned how to harness flowing water with

(*Continued on page 188*)

The Development of Artillery Matériel

By MAJOR G. F. JENKS,[1] WASHINGTON, D. C.

The first portion of this paper is a consideration of artillery-materiel development before the war and the effect of the war upon it, both in this country and abroad. Mechanical traction, it is stated, permits the increased weights required for long-range artillery; increased speed permits rapid strategic concentration of artillery; high-grade steels permit greater power in guns. All of these factors are important to the artilleryman. The efforts of the ordnance engineer since the war have been devoted for the most part to the development of pieces of greater range, greater elevation and greater mobility. The author points out the lines of development which are being followed, outlining gun-construction methods now in use and showing the value of the research work now being carried on. He describes different models of howitzers, guns and mounts, and discusses some of the details of design of recuperators, carriages, and sighting systems. The paper closes with a survey of the development of anti-aircraft materiel and coast-defense work.

ALL wars have stimulated the development of the implements of warfare. Especially during the past war have the minds of engineers been fertile. New implements of war have been conceived and developed. Old ones have been given the supreme test and found capable of further development. Of the problems arising from the war none is more important or more interesting than the development of artillery matériel. In analyzing it a brief consideration of its state before the war and the effect of the World War upon it, both in this country and abroad, is necessary.

The field gun with which our service was equipped prior to 1917 was developed about 1902 to meet the demands for a stable gun carriage—one in which the aiming of the piece was not disturbed by the shock of firing. No marked developments in design then took place until the invention of the split-trail carriage, by which large increase in both traverse and elevation of the piece was made possible. In 1912 the Ordnance Department initiated the design of such a carriage, which, after exhaustive proving-ground tests, was put into production in September, 1916.

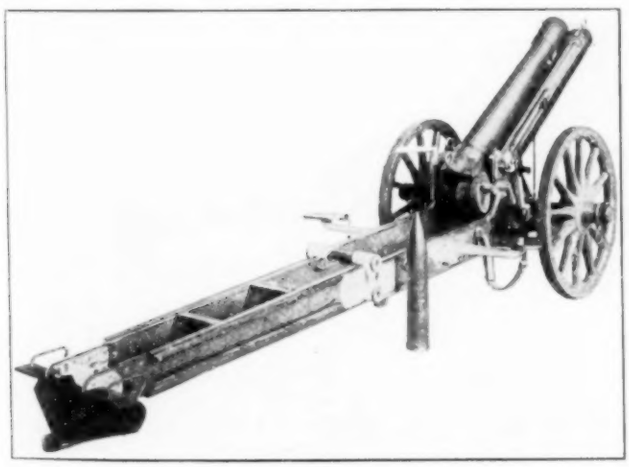


FIG. 1 75-MM. PACK HOWITZER, MODEL OF 1920

The design of howitzers and medium-caliber guns was limited by road conditions in this country. In these pieces power was sacrificed to obtain the necessary mobility. It had been considered impracticable to use heavy siege guns and howitzers on this continent and none had been provided for our troops.

For war manufacture French and British designs were adopted for all calibers of guns and howitzers except the 4.7-in. field gun. The French 75-mm. field gun was put into production because the American split-trail carriage had not been thoroughly tried out in service and the British 75 was ordered because production facilities were available.

The United States entered the war with neither an adequate engineering force to develop new designs nor a trained production force to organize manufacture. It had merely a handful of matériel and practically no facilities to produce it. Our allies not only furnished us matériel, but gave us their designs and detail drawings

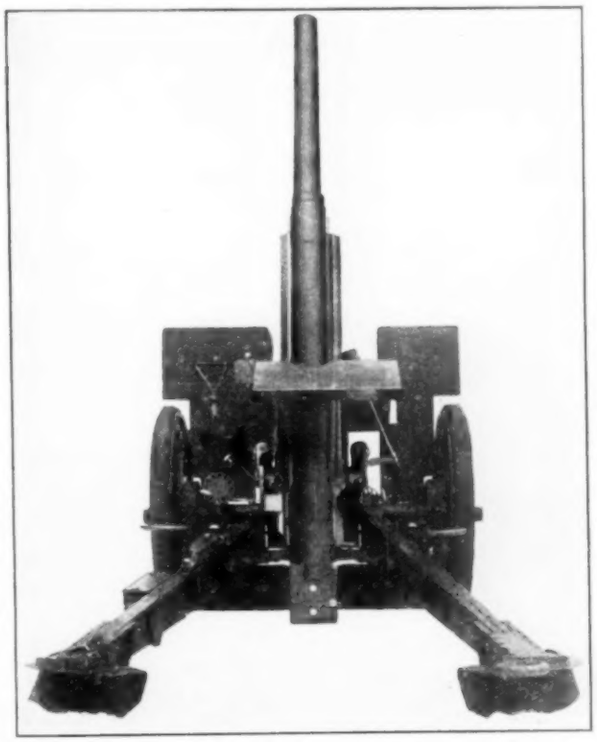


FIG. 2 75-MM. GUN, MODEL OF 1920

and their design and production engineers to assist us in organizing production. Most of our own engineering talent was required to solve the problems of production. Considerable new development work was initiated during the war. Although working under war pressure, time was too short to secure results. Had the war continued, some real development work might have been accomplished with the large, earnest organization built up during the war.

On the other hand, much was accomplished abroad in the development of artillery matériel. The French developed long-range siege artillery and were about to bring out the design of a new field piece. They also succeeded in increasing the mobility of siege guns. The British gradually improved the range characteristics of their artillery during the war and had under manufacture an excellent design of a new field gun.

The Germans easily ranked first in the development of artillery during the war. They developed and manufactured greatly improved pieces of all calibers. They recognized the value of range, not only in the design of more powerful guns of a given caliber, but also in mounting these guns on carriages so that their maximum range could be secured. By the use of these pieces in the spring offensive in 1918, the Germans caused much concern to the allied artillery commander. This statement does not refer to the "big Bertha" fired against Paris, which was of little or no direct military value.

One well-known American artillery commander reported under date of October 8, 1918, after remarking on the changed German tactics made possible by the introduction of their improved artillery in the spring of 1918:

[1] Ordnance Department, U.S.A. Mem.Am.Soc.M.E.

Paper presented at a meeting of the Washington Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS at Washington, D. C., December 2, 1920.

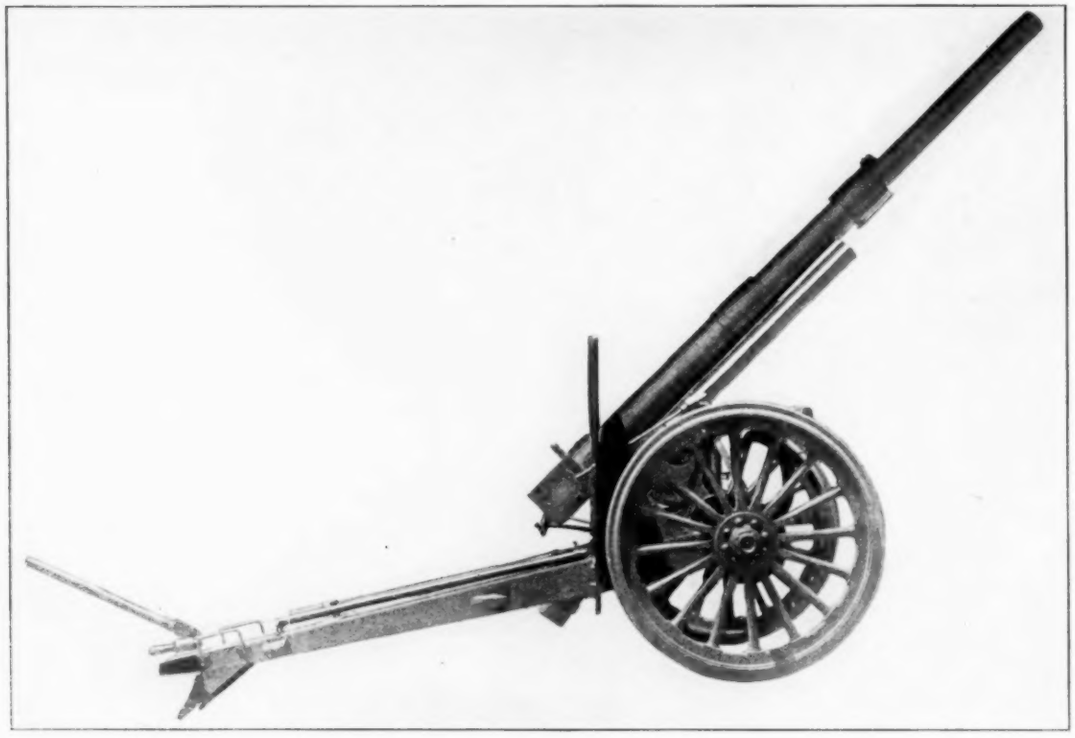


FIG. 3 75-MM. GUN, MODEL OF 1921

Under these circumstances, the trench mortars and short-range antiquated French guns that we install and supply with ammunition with so much labor, are of little or no use. They pound an empty space and we cannot move them forward over No-Man's Land and supply them with ammunition..... For the present phase of the war, then, range is a most vital consideration. The Germans have increased the range of their guns..... To contend with these German guns, or in other words, to meet the condition, in the existing phase of the war, we must have guns and howitzers of long ranges.

Prior to the war the marvelous progress in the mechanical arts caused by the development of the gas engine had had no appreciable effect upon the design of artillery matériel. The field piece had been conceived in terms of the horse, the mountain howitzer in terms of the pack mule. Very little progress had been deemed possible as the horse was a fixed quantity. But the perfection of the gas engine has removed the horse as a limiting factor. The development of the automobile industry has given us high speeds of vehicle propulsion, and a demand for and supply of alloy steels of high physical properties. All these factors are important to artillerymen. Mechanical traction permits the increased weights required for long-range artillery. Increased speed permits rapid strategic concentration of artillery; high-grade steels permit greater power in guns.

DEVELOPMENT OF THE LONG-RANGE GUN

After the armistice the sentiment of our artillerymen was unanimously in favor of pieces of greater range, greater elevation, and greater mobility. This sentiment found expression in the reports of the various service boards and especially in that of the Westervelt Board appointed by the War Department, December 11, 1918. The report of this Board was approved by the Chief of Staff on May 23, 1919, and its recommendations have become the fundamental specifications for mobile artillery matériel.

The efforts of the ordnance engineer since the war have been devoted mostly to the development of design under the Westervelt Board program. Under that program the same calibers of pieces as used during the war will be developed, but they will have greater range, greater flexibility of mount, and greater mobility.

The longer range will be attained partly through ammunition development, but also by increase in the length and muzzle velocity of the gun. As mobility requires lightness, the weight of the gun must be reduced as much as possible. To secure this, three lines of development are being followed: first, by using material of higher

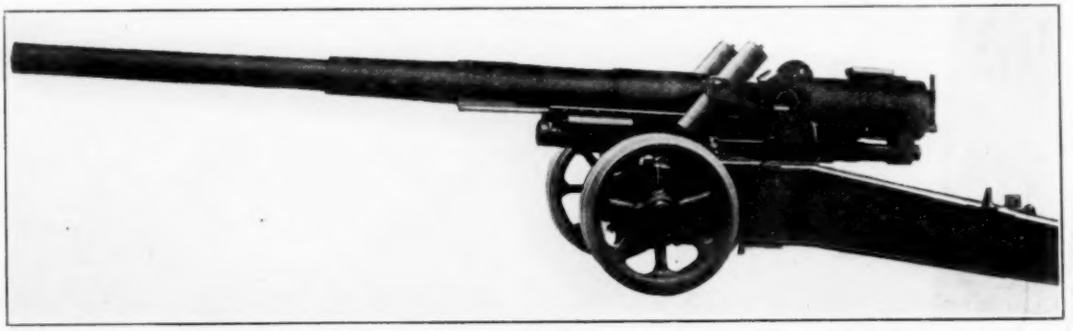


FIG. 4 155-MM. GUN, MODEL OF 1920

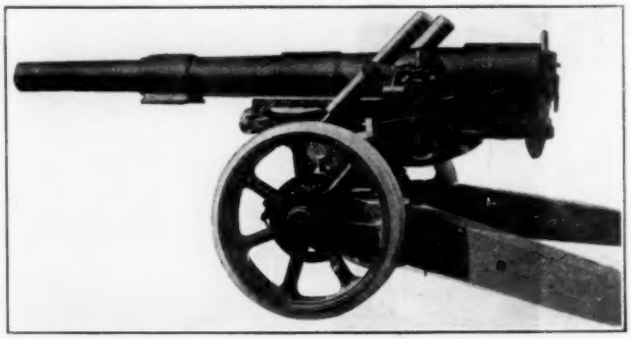


FIG. 5 155-MM. HOWITZER, MODEL OF 1920

physical qualities: second, by wire-wrapping the tube; and third, by the "auto-frettage" process.

The nickel steel specified during the war was of the following physical qualities: elastic limit, 65,000; tensile strength, 95,000; elongation, 18 per cent; contraction, 30 per cent. Gun forgings for some experimental matériel are being made of nickel-chrome steel with the following physical qualities: elastic limit, 80,000; tensile strength, 105,000; elongation, 18 per cent; contraction, 30 per cent. Such forgings have been produced, but many problems have arisen in their production. Some of the first produced were extremely brittle and under stress behaved like cast iron. One small gun which seemed to be made of excellent metal according to the usual methods of test, failed under less-than-service interior pressure. Impact tests developed the fact that an improper heat treatment had been given. This brittleness has apparently been overcome by quenching the forging from the "draw." But, although impact tests have shown excellent results, yet the metal is full of internal stresses and the gun finisher experiences considerable difficulty in keeping the bore straight. What effect these internal stresses will produce at the proving ground is not known. Laboratory tests made upon the steel of captured German guns indicate that this kind of steel was used successfully and that it was tough, free from internal stresses, and remarkably uniform. Much work still remains to be done in developing a satisfactory steel of this quality.

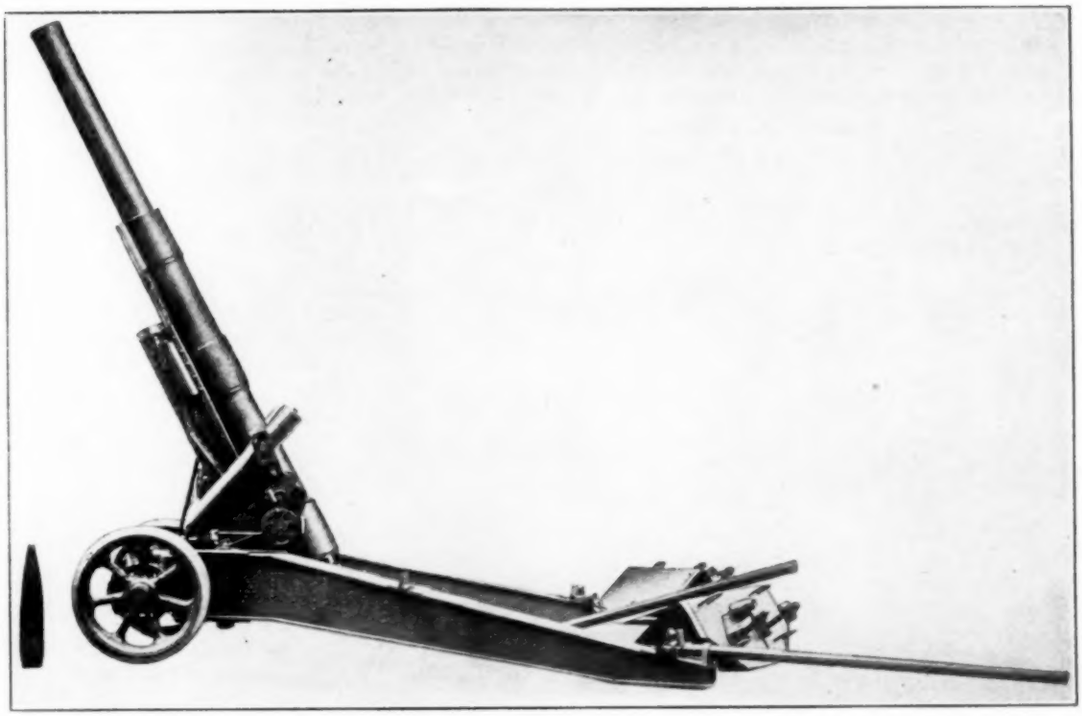


FIG. 6 8-IN. HOWITZER, MODEL OF 1920

No new problems are involved in the construction of the wire-wrapped gun. By the use of wire, lower-grade metal can be utilized in the forgings. Guns made by this process are slightly heavier than those made of chrome alloy steel. At present, however, it is a more conservative method of construction.

In the auto-frettage method of construction the gun is built up of a few pieces of steel of medium physical qualities. The walls of the gun are internally stressed beyond their elastic limit by internal hydraulic pressure. The condition set up is similar to that produced by the shrinking process. It can be applied to the whole gun, whereas the effect of shrinkage is limited to the hooped portion. For a given strength thinner walls are sufficient. This assures minimum weights. The process is also a cheaper one than either the built-up or the wire-wrapped method of construction.

GUN-CONSTRUCTION RESEARCH

A research program has been undertaken at Watertown Arsenal to determine the laws underlying the auto-frettage process. One 155-mm. howitzer is now ready for auto-fretting. Although others have constructed and tested guns built up by auto-frettage, our program covers an investigation of the principles and theory rather than hasty proving-ground tests.

Much research work still remains to be done in determining the proper form of rifling, the effect of variation of elements of the bore upon the life of the gun, the production and heat-treating of metals used in gun construction, and in checking the fundamental formulas of gun design. Our knowledge of the theory of gun construction is rather unsatisfactory.

For pack howitzers and field and siege pieces of 75-mm. and greater caliber, the hydropneumatic recuperator is being employed. The St. Chamond type is used for 75-mm. and 105-mm. calibers and the Filloux type for 4.7-in. to 8-in. calibers. No new developments have been made in these types since the armistice. They have been merely adapted to meet the new conditions imposed.

During the war great difficulty was experienced in the production of recuperators. Because of the use of oil and air under high initial pressure extremely fine workmanship was required in the finishing of the bore of cylinders and the manufacturing of pistons. If possible a recuperator which is simpler to manufacture should be developed.

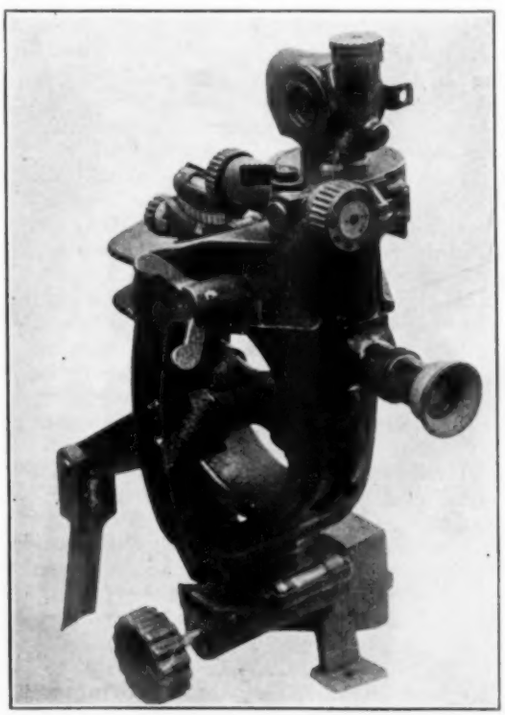


FIG. 7 SIGHT FOR 75- AND 105-MM. MATERIEL, MODEL OF 1920

Such a development is being carried on. In this system the air is confined in a metal bellows. Complex pistons to hold pneumatic and initial hydraulic pressures are eliminated. Such a system offers much simpler production problems.

Carriage Developments

Two independent lines of carriage development are being pursued: the wheel type and the caterpillar type. Common desirable charactristics are high elevation, wide traverse, a minimum depth of pit for clearance of recoil parts at high elevation, and, of course, stability at all elevations.

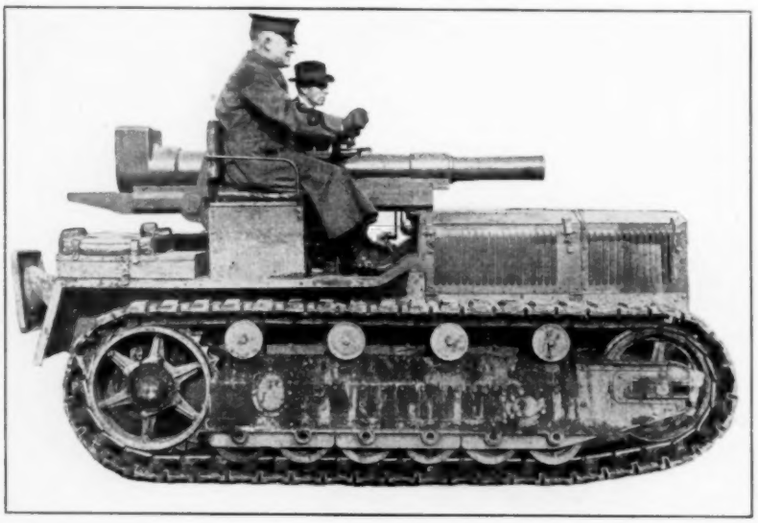


Fig. 8 Self-Propelled Caterpillar Mark VI for 75-mm. Gun and for 105-mm. Howitzer, Model of 1920

The condition of high elevation and minimum depth of pit has necessitated placing the center of trunnions of the tipping parts in rear of their center of gravity, and equalizing the force required to elevate and depress by an equilibrating system. In most pieces it requires variable recoil. Although the equilibrating system adds weight and complexity to the gun carriage, yet it tends to improve the accuracy of fire as the pressure on the elevating gears does not change in direction during the recoil. This should keep the backlash of gearing in the same direction and reduce the jump.

Bringing the center of rotation of the gun to the rear and the use of variable recoil also permits lowering the axis of the gun. This is advantageous in permitting lightness of construction and shortening the trail.

Wide traverse has resulted from the use of the split trail at the expense of weight and simplicity of construction. The split-trail 75-mm. matériel weighs about 700 lb. more than the box-trail matériel. This is due partly to the greater elevation—80 deg. compared with 40 deg. It is believed that the simpler, lighter and more rugged single-trail is by far the preferable design for the 75-mm.

The provision for elevating pieces beyond that required for maximum range is causing complication of design and increased weights. The bottom carriage must be built out farther from the axle to permit clearance at high elevations. This is expensive in weight.

The Westervelt Board report contemplates a gun and a howitzer mounted on the same carriage. This simplifies production and supply, but it complicates the design of the carriage. It is difficult to secure the same reactions in the carriage from both gun and howitzer. For example, the 4.7-in. gun matériel is heavier than it need be because the 155-mm. howitzer demands a heavier carriage. It appears preferable not to attempt the use of exactly the same carriage for both pieces, but merely to make them as nearly alike as practicable. The ideal of the artilleryman is the reduction of the number of calibers to a minimum and the standardization of mounts. The desirability of such a program is apparent to the supply department charged with production and maintenance. However, the mission of the piece—not the desirability of standardization—must fix its characteristics.

In the development of the wheel-type mount it is probable that in some cases we have overstepped the boundary of conservative design, and that later we will be content to reduce the severity of some of our specifications in order to simplify and lighten our designs. However, the present designs incorporate characteristics that seem desirable. Until pieces embodying them are constructed and tested, the engineer will not be content that these characteristics are feasible, and the service will not be satisfied that they cannot be embodied in their matériel.

Sighting Systems

No marked development is being attempted in sighting systems. Of course panoramic sights or suitable telescopic sights will be used for all calibers. The field-gun sight follows that developed for the 75-mm. model-of-1916 matériel and the sight for heavier guns will be a modified quadrant sight like that used on the 155-mm. howitzer, but with a panoramic sight. For accompanying fire-control instruments only minor improvements are now contemplated.

Caterpillar Mounts

In the war models of caterpillar mounts, little attention could be given to reduction in weight and to refinement in design. The possibilities of development of these types of gun mounts should not, therefore, be judged by the matériel built under war contracts, nor even by that now being constructed. Especially, such essential characteristics as accessibility of parts for maintenance and elimination of mechanical weakness in details of construction must be worked out by experience. In considering any model the possibilities of perfecting the design into a desirable machine must be given the greatest weight. Mechanical imperfections can be eliminated.

Caterpillar-mount development is now proceeding along two lines: first, the track-laying type found in tractors; and second, a combination wheel and track-laying type in which the mount may be operated on wheels on good roads, or on tracks where road conditions are bad.

Fig. 9 Self-Propelled Caterpillar (Christie) for 155-mm. Gun, Model of 1918

Both types are self-propelled and have similar gun characteristics. Weights are about the same and speeds are similar. Because of the promise of both types, light and heavy-gun pilot matériels of both are being built. The 75-mm. gun and 105-mm. howitzer matériels are being designed and built by the Holt Caterpillar Company and by the Front-Drive Motor Company. Good compara-

tive tests of the two principles of construction should be obtained from these pilots.

Some 155-mm. gun caterpillar mounts designed by Mr. Christie of the Front-Drive Motor Company are nearing completion for a service test. Six caterpillar mounts for the same gun made according to a Holt design are now in the hands of the service. No decision should be drawn, however, from a comparative test of these two current models, as the Holt Company is now designing and constructing an improved mount. For the 4.7-in. gun and 155-mm. howitzer the Holt type only is being developed at this time.

The specifications of the Westervelt Board report for range of the heavy howitzer and gun for caterpillar mounts are very severe. The howitzer required is about the same length in calibers as the 155-mm. gun used during the war, while the gun is the same as for railway mounts. While it is possible to handle such guns in the field on self-propelled or trailer caterpillar mounts, yet it appears probable that the service prefers greater mobility and ease of getting into firing position at the expense of range. No decision has yet been reached in the characteristics of these pieces.

The ideal traverse as expressed by the Westervelt Board report is 360 deg. This is being secured only in anti-aircraft mounts in which the gun is pivoted on a pedestal. Mechanism will be provided in caterpillar mounts to traverse the whole mount by hand power. Of course this is a compromise, but the best practicable at this time. Mounting guns on a pivot like that in the anti-aircraft mount requires increased height of trunnions and heavy mounts—both undesirable features.

Infantry Howitzers

In the infantry-accompanying howitzer an attempt is being made to develop a piece which can be used either as a direct-fire gun aginst tanks or as a howitzer, taking the place of the 3-in. trench mortar. Guns of the 1.8-in. and 2.24-in. caliber are under construction. The caliber suitable for an anti-tank gun is too small for an efficient howitzer projectile. It is believed more logical to recognize the difference in mission of the two pieces and to develop efficient designs for both missions. The piece will be capable of being broken up into man loads.

Anti-Aircraft and Coast-Defense Work

For anti-aircraft matériel the development of a satisfactory fuze for high-muzzle velocities is a limiting factor. Two calibers

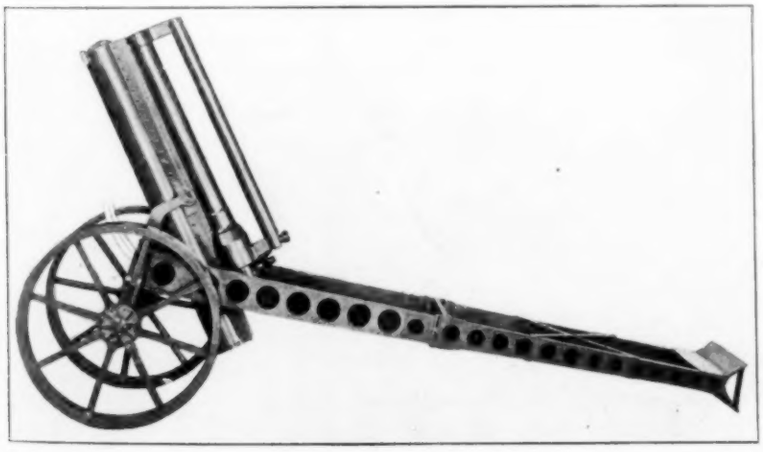


Fig. 10 2.24-in. Infantry Howitzer, Model of 1920

of guns are being developed, 3-in. and 4.7-in. The mounts will be capable of being leveled on the caterpillar base. The sighting system permits the application of azimuth and elevation corrections and superelevation without disturbing the pointing of the sight. Compressed air will be used for loading. In the heavier gun a muzzle brake will be developed in order to lessen the load on the recuperator. With other guns almost 85 per cent of the recoil energy has been absorbed in a muzzle brake, but only about half that efficiency is expected in this case. For anti-aircraft work, however, the big problem is to develop a satisfactory sighting and fire-control system.

For coast-defense work the 16-in. 50-caliber gun and the 25-caliber 16-in. howitzer are now standard. Only one disappearing carriage for the gun is being built. Both guns and howitzers will be mounted on barbette carriages capable of 65 deg. elevation. Hydropneumatic recuperators permit this use of increased elevation. The

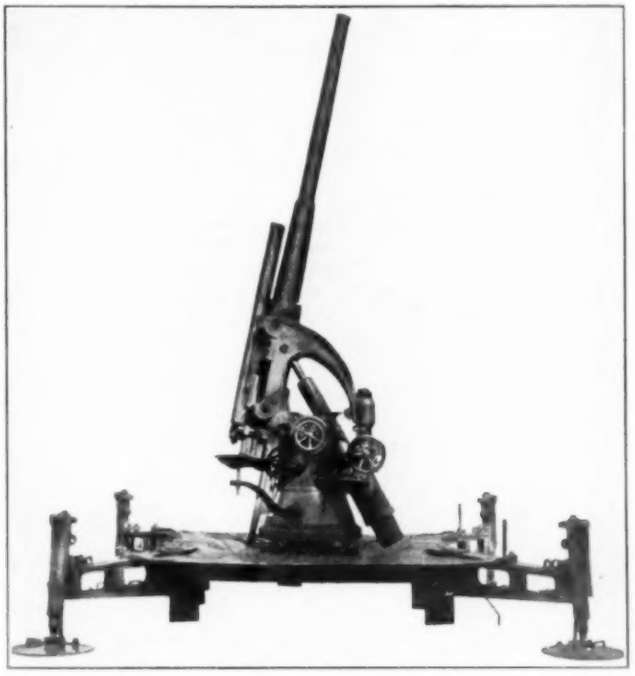


Fig. 11 3-in. Anti-Aircraft Gun Mount, Model of 1920

14-in. 50-caliber gun is also standard for coast defense. For it a new type of railway mount suitable for both field and coast-defense work is under manufacture. For coast defense a concrete foundation permits of 360 deg. traverse, while for field work traverse can be obtained from a curved track. The same railroad mount will take the 16-in. howitzer. A railway mount for a 12-in. 20-caliber howitzer is now under test. The howitzer is capable of all-around fire from the car body. The same type of carriage can be developed for an 8-in. 50-caliber gun, but lack of funds has not permitted the undertaking of this work. Studies have not yet advanced sufficiently to warrant a definite statement as to whether it is practicable to mount guns of larger caliber than 14-in. on railway mounts.

The present tendency is toward more powerful guns for seacoast defense. Some gain in power may be obtained by increasing the length and muzzle velocity, but the logical step is an increase in caliber. If economy is to be exercised in the construction of fortifications, they should be armed with guns which are at least two decades ahead of naval armament in development.

A large problem is the development of fire-control matériel for heavy coast guns. Range-finding and observing instruments set up in the neighborhood of the battery are insufficient. Guns are now capable of reaching targets which are below the horizon to our present fire-control stations. The observer is forced into the air, where the difficulties of leveling and orienting instruments are tremendous. An observation instrument leveled and oriented by gyroscopes is nearing completion. It is rather complex and no hopes can be given as to its ultimate utility. In the development of accessory instruments good progress is being made.

This rapid general survey indicates the enormous extent of the field in which artillery development work is required. It is impossible in a limited paper to indicate the depth of the program by touching upon the numerous problems which the research engi-

neer must solve in the laboratory. Needless to say, years of intensive work are required. As the stock of artillery matériel on hand is sufficient for any present needs, time should be available to perfect matériel and thoroughly test it before production should be required. Only an engineer familiar with the cost in the past of putting types of matériel into production before the design has been carefully tested at the proving ground and in the field can realize the enormqus saving to the Government of fully developing artillery matériel on a small scale before equipment of armies is required.

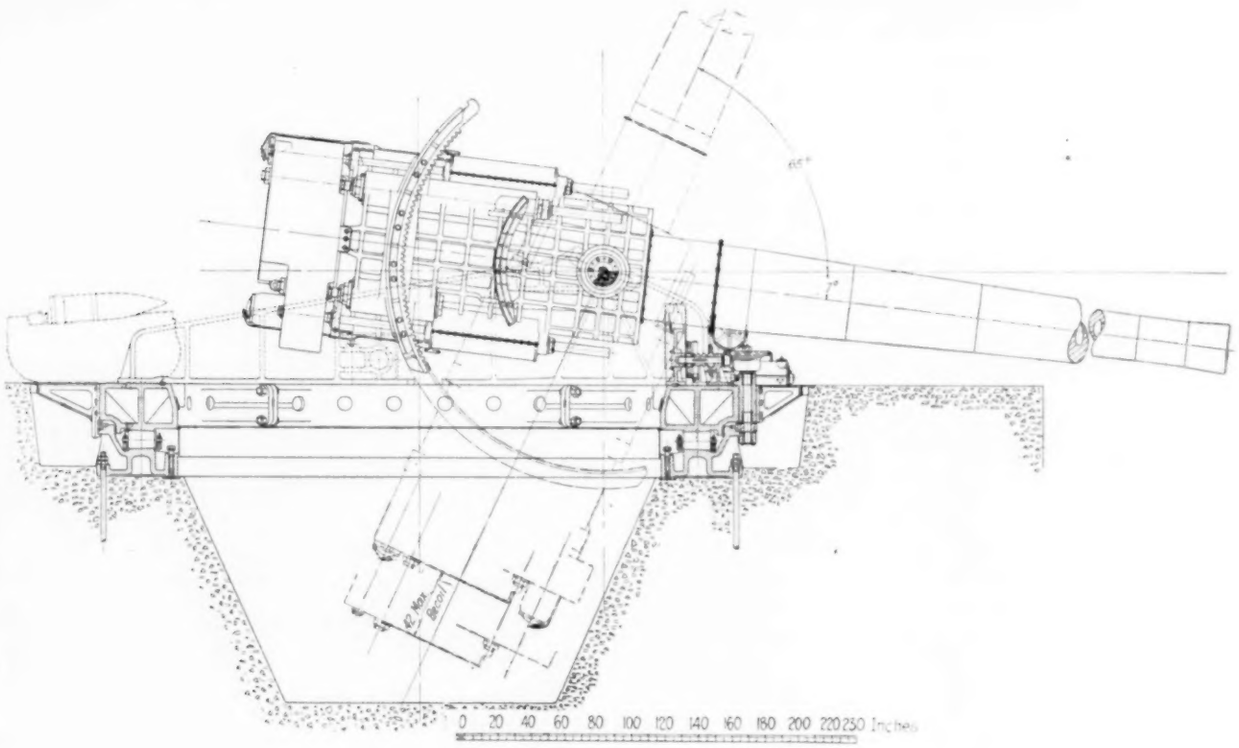


FIG. 12 16-IN. BARBETTE CARRIAGE, MODEL OF 1919

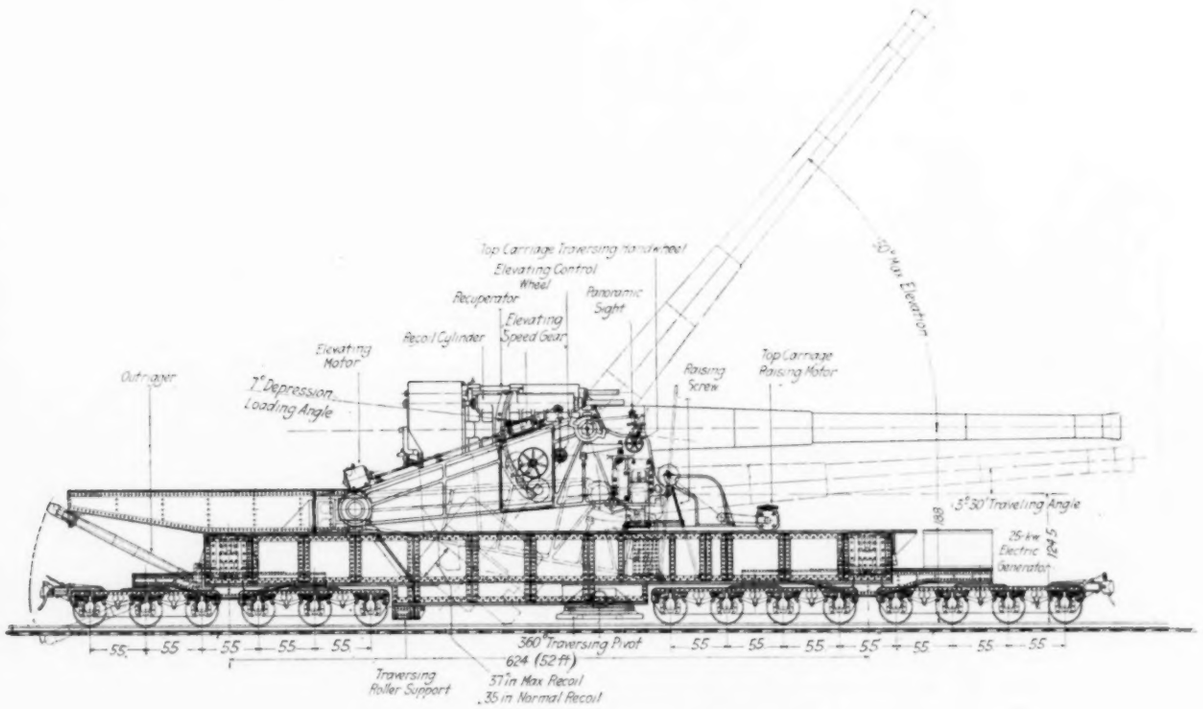


FIG. 13 14-IN. RAILWAY MOUNT, MODEL OF 1920

Cylindrical Grinding in 1920

Factor Which Determine Wheel-Wearing Action—Laws Relating to Draw-In and Traversed Cuts—Production Costs

By W. H. CHAPMAN,[1] WORCESTER, MASS.

[This paper comprises a study of the laws involved in cylindrical grinding and an analysis of grinding action both for draw-in cuts and traversed cuts. In view of the effect of wheel wear on grinding efficiency, formulas are derived for wheel wear in terms of known variables such as grain size of wheel, work speed, wheel speed, feed, etc. By calculating values for wheel wear for different conditions and comparing them with production figures calculated under the same conditions, a proper selection of wheels may be made.

The fact that the expense due to wheel wear comprises but a small item in the total cost of grinding, however, may lead to wrong conclusions if this is made the controlling factor. In the latter part of his paper, therefore, the author discusses the subject of production costs and the various factors that should be considered in securing the highest possible grinding efficiency.—EDITOR.]

IN Fig. 1 is shown a section of wheel and work with the elements greatly enlarged. The grain paths across the work are indicated and a shaded area indicates the shape of a single chip. The grain paths are shown as straight lines tangent to the feed circle. Actually these paths are not straight lines but are epicycloidal curves. However, within the limits of probable dimensions which are actually involved in any cylindrical grinding operation, a graphical layout of the grain paths on a large scale (say $^1/_4$ in. = 0.0010 in.) will show that these curves are so nearly straight lines that the error is negligible. The mathematical relations are greatly simplified by this assumption. By actual trial it was found that there was seldom over 2 per cent difference in the values of maximum chip depth obtained by the use of the *actual* and the *assumed* forms of grain path.

WHEEL-WEARING ACTION

The three factors to be considered as determining wheel-wearing action are (1) the frequency with which the grain is applied, (2) the average grain depth of cut as indicated by the chip dimensions, and (3) the kinetic energy of the grain due to its mass and velocity.

[In his complete paper, the author here discusses the three factors mentioned and derives the formulas given below for grain depth of cut and for wheel wear, using the following notation:

N = r.p.m. of wheel
V = surface speed of wheel, ft. per min.
u = work speed in ft. per min.
R = wheel radius in inches.
r = work radius, inches
f = depth of cut, inches on work radius
μ = interval between grains, inches
S = radius of feed circle = $r - f$, inches
G = maximum depth of chip, inches.]

Frequency of application depends upon the revolutions per minute of the wheel. Work done is measured by the dimensions of the chip removed by each grain and the total number of chips removed. Kinetic energy is proportional to the mass and square of the velocity of the cutting particles.

Frequency of application of the grain $= N = \frac{12V}{2\pi R}$, and volume of wheel wear $= \frac{12V}{2\pi R} \times 2\pi R$. Therefore wheel wear is directly proportional to $12V$; or dropping the constant, is directly proportional to V.

The formula for grain depth of cut, as derived in the complete paper, simplified by the omission of inconsequential terms, is

$$G = \frac{\mu u}{V}\sqrt{\frac{2f}{r}} \text{ (approximately)} \quad \ldots\ldots [1]$$

From this it is deduced that grain depth of cut varies directly with grain interval, work speed, and square root of radial feed; and inversely with wheel speed, and square root of work radius.

The kinetic energy of the cutting particles increases with the square of the velocity.[1] For a certain depth of cut the resistance of the work to the grain is very nearly proportional to this depth, as the cuts are very small, even when compared to the total size of the grain. Theoretically, for some low velocity the kinetic energy of the grain should just equal the energy required to remove the chip (the feed would be reduced to maintain constant grain depth of cut under reduced wheel-velocity conditions) and wheel wear would be caused without any chip being removed up to this point. Actually the bond strength is always sufficient to prevent this condition. Our assumption is then clear that:

Wheel wear varies inversely with the *surplus* kinetic energy of cutting particles and is inversely proportional to *effective* wheel surface velocities (wheel speed minus work speed).

We are now prepared to combine factors.

a Wheel wear is proportional to the wheel speed, or to V.

b Wheel wear is proportional to the grain depth of cut, as expressed in Formula [1].

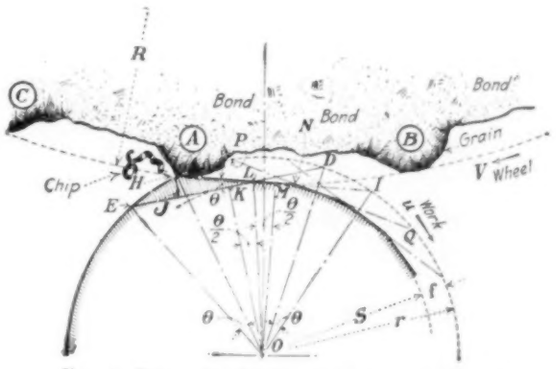


FIG. 1 DIAGRAM ILLUSTRATING CUTTING ACTION

c Wheel wear is inversely proportional to surplus kinetic energy of the cutting particles, or proportional to $1/(V-u)^2$. The term u is usually negligible as compared with V and it may therefore be assumed that $1/V^2 = 1/(V-u)^2$.

From these relations, *a*, *b* and *c*, an index of wheel-wearing action (WW_1) due to grinding (where the wheel face is free-cutting) may be expressed as follows:

$$WW_1 = V\frac{\mu u}{V}\sqrt{\frac{2f}{r}} \times \frac{1}{V^2} = \frac{\mu u}{V^2}\sqrt{\frac{2f}{r}} \quad \ldots\ldots [2]$$

LAWS OF GRINDING FOR DRAW-IN CUTS

From this expression we may derive the following laws of cylindrical grinding, operative *within the usual limits of speeds and dimensions*. For straight-in (draw-in) cuts a free-cutting wheel will wear according to the effect of wheel-wearing action as follows:

a Wheel-wearing action increases directly as:
1 Grain interval (grain size—inversely as grade)
2 Work speed (surface)
3 Square root of diametral cut (feed).

b Wheel-wearing action increases directly as the following are decreased:
1 Square of wheel speed (surface)
2 Square root of work radius.

[1] Norton Co.

Abstract of a paper presented at the Annual Meeting, New York, December 1920, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

[1] See Selection of Grinding Wheels for the Foundry, *Grits and Grinds*, Jan., 1915, The Norton Company, Worcester, Mass.

A soft wheel is more susceptible to wheel-wearing action than a hard wheel and will more nearly follow the theoretical conditions. It is therefore more free-cutting and will cut more nearly the full chip than a hard wheel. There is consequently a gain in production as wheels of softer grades are used, all other conditions remaining constant, up to the point where the chips are geometrically perfect for a given condition of speeds and dimensions. It is clear from this standpoint that the softest possible wheel should be used. High wheel speeds up to the safe limit are of course necessary if the soft wheels are to perform in a satisfactory manner.

To show the practical application of Formula [2] for wheel-wearing action (Index of Wheel Wear), Table 1 is given.

In column 1 of the table are the work speeds provided on a recent grinding machine, given in order so that actual values can be experimentally obtained to check with the theoretical. In the succeeding columns are two series of values as follows:

1 Following the term "Production" are *approximate* values for cubic inches of metal removed per minute for a wheel 1 in. wide. These were calculated by the formula, Production = nominal work diameter $\times \pi \times$ r.p.m. $\times$ depth of cut (assumed to be 0.0005 in.), which gives values slightly less than the true values.

2 Following the terms "Wheel Wear" are values of the *actual* wheel wear obtained by multiplying the Index of Wheel Wear, calculated by Formula [2], by a constant derived by experiment. This constant is for convenience expressed in the form 1800×10^4.

Sample Calculation. In Formula [2] assume:

u = 53 r.p.m. = 13.9 ft. per min.
r = $\frac{1}{2}$ in. (work diameter 1 in.)
f = 0.0005 in.
V = 6000 ft. per min.
μ = 0.05
R = 9.0 in. (wheel radius)

Substituting,

$$WW_1 = \frac{0.05 \times 13.9}{36{,}000{,}000}\sqrt{\frac{0.001}{0.5}}$$
$$= 0.0000000196 \times 0.047 = 9212 \times 10^{-13}$$

Multiplying by constant given above (1800×10^4),

$$WW_1 = 0.0166 \text{ cu. in. per min. for wheel 1 in. wide.}$$

The corresponding "Production" in Table 1 is 0.0835 cu. in.

It will be seen that the wheel-wear values increase rapidly as work speed increases. The value 0.0166 for work of 1 in. diameter at 53 r.p.m. becomes 0.1040 for work of 4 in. diameter at 167 r.p.m. The same wheel cannot be properly used for both cases, as one sufficiently soft to cut freely in the first case would wear so fast as to be nearly useless in the second case. However, where wheel-wear values are nearly the same we may expect the same wheel to act properly. For instance, a wheel suitable for 1-in. work at 138 r.p.m. wears at the rate of 0.0433 cu. in. per min.; and one suitable for 4-in. work at 72.5 r.p.m. wears at the rate of 0.0450 cu. in. per min. In all probability one wheel would serve for both.

Selection of Wheels for Draw-In Cuts

From Table 1, and by experimental tests with various wheels, certain ranges of wheel-wear values may be found which correspond

TABLE 1 COMPARISON BETWEEN WHEEL WEAR AND QUANTITY OF METAL REMOVED AT DIFFERENT WORK SPEEDS

Work Speed in r.p.m.		Work Diameters 1 in.	2 in.	3 in.	4 in.
53	Production	0.0835	0.1670	0.2500	0.3340
	Wheel Wear	0.0166	0.0236	0.0290	0.0334
72.5	Production	0.1140	0.2280	0.3420	0.4560
	Wheel Wear	0.0226	0.0319	0.0390	0.0450
87	Production	0.1370	0.2740	0.4110	0.5480
	Wheel Wear	0.0273	0.0387	0.0475	0.0546
101	Production	0.1586	0.3172	0.4758	0.6344
	Wheel Wear	0.0316	0.0448	0.0540	0.0635
138	Production	0.2160	0.4320	0.6480	0.8640
	Wheel Wear	0.0433	0.0612	0.0645	0.0865
167	Production	0.2620	0.5240	0.7860	1.0480
	Wheel Wear	0.0522	0.0740	0.0910	0.1040

Wheel diameter 18 in.; surface speed, 6000 ft. per min.; diametral feed per work revolution (automatic feed), 0.001 in.; grain of wheel, 6646 Alundum; material, mild machinery steel.

to definite grades of wheels of suitable grain size and abrasive for the material to be ground. Once this is done, the selection of proper wheels is no longer a question of guesswork, as wheel-wear indices may be computed for any set of conditions and the proper wheel selected. The question of the variation in wheels has been reduced to a point where it no longer can be a very large factor, and we may always change our speeds or feeds to correct the action in the proper direction if we understand the laws which have been previously pointed out. As an example of the possibilities of wheel selection, it has been found that for a certain machine the following wheels (Norton system of grade) are suitable for straight-in cuts on mild steel:

Wheel Designation		Wheel-Wear Values, Table 1
36 or 46 J	for values from	.0150 to .0250
36 or 46 K	for values from	.0250 to .0350
36 or 46 L	for values from	.0350 to .0450
36 or 46 M	for values of	.0450 and higher

Use no wheels harder than M. For hard materials use a grade softer and No. 60 grain. These values are for straight-in cuts only.

Influence of Feed. As an example of the effect of doubling the feed, let us assume the conditions as above, except that the feed is increased to 0.001 in. (on radius).

$$WW_1 = \frac{\mu u}{V^2}\sqrt{\frac{2f}{r}} = \frac{0.05 \times 13.9}{36{,}000{,}000}\sqrt{\frac{0.002}{0.5}}$$
$$= 1240 \times 10^{-13}$$

Wheel wear = $1800 \times 10^4 \times 1240 \times 10^{-13} = 0.0224$ cu. in. per

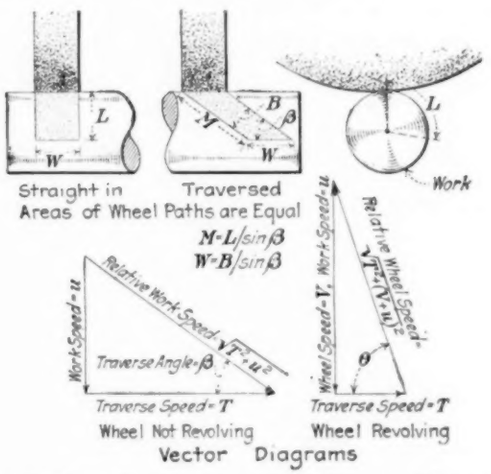


Fig. 2 Speed Relations between Work and Wheel

min. per inch of wheel face. Production is approximately doubled and

$$\text{Wheel-wear increase} = \frac{0.0224 - 0.0166}{0.0166} \times 100 = 35 \text{ per cent.}$$

This indicates how advantageously an increase of feed operates to obtain increased production (up to the limit of grain penetration). If we had doubled work speed we would simply have doubled both production and wheel wear.

Traversed Cuts

The most important development in recent grinding machines is the recognition and utilization of the fact that overall operating efficiency for traversed cylindrical work *increases* as *traverse speeds are increased.* (This assumes that for a given traverse speed, width of wheel and revolution of work are so related as to cause the cutting face to just cover the lead of the work.)

Referring to Fig. 2, let

W = width of wheel face
L = length of projected arc of rotation of work
M = actual length of path of traversed cut
B = actual width of path of traversed cut
β = traverse angle

Then $B = W \sin \beta$; $M = L/\sin \beta$; areas $W \times L$ and $B \times M$ are equal. Wheel width of cut is proportional to W for straight-in cut, but reduced to B for traversed cut.

It is to be noted that relative work speed has been increased over actual work speed in the inverse proportion of the sine of the traverse angle. This relative increase does not appear in the projected (end view) relations. As these alone affect individual grain depth of cut, we have gained in relative work speed to get over the longer path M so as to cover the same area in the same time on a narrower width, B, *without* increasing grain depth of cut.

Now if the wheel rotates, each grain cuts across the work at an angle θ, resulting from speed relations shown by Fig. 2 (vector diagram for rotating wheel). Then the individual grain paths are at a much steeper angle than the wheel path to the axis of work rotation, but we have gained in relative wheel speed *without* increasing individual grain depth of cut. Our wheel width of cut is also reduced by a slight amount proportional to sin θ, which is of course much less than the reduction before the wheel was rotated. The net result is a reduction in wheel stress proportional to sin θ and an increase in work speed proportional to sin β, *without* increase in grain depth of cut.

The "head resistance" against the wheel as a whole is reduced by the sin β factor, while wheel width of cut is reduced by sin θ. These both directly affect wheel wear. For traversed-feed conditions our grain depth of cut remains the same as in straight-in feeds, but wheel wear is reduced in the proportion of sin $\beta \times$ sin θ.

If T = traverse speed, V = wheel speed, u = work speed, then

$$WW_1 = \left(\frac{u}{\sqrt{T^2 + u^2}}\right)\left(\frac{V + u}{\sqrt{T^2 + (V + u)^2}}\right)\left(\frac{\mu u}{rV^2}\right)\left(\sqrt{2rf}\right) \quad \ldots [3]$$

In practical cases the second term will be so nearly 1 that it may be neglected. It is evident that T affects the quantity appreciably only when u is kept relatively low. This indicates that a wide wheel should be used to get the effect of reduced wear for a given production, traversing as rapidly as possible. The above formula assumes no overlapping of the cut.

Now by making assumptions and neglecting values whose effect is so small as to make no appreciable difference for purposes of comparison, we reduce the expressions for WW_1 exactly as we did in the case of straight-in feeds and obtain:

$$\text{Index of wheel wear } WW_1 = \frac{\mu u}{V^2}\left(\frac{u}{\sqrt{T^2 + u^2}}\right)\sqrt{\frac{2f}{r}} \quad \ldots [4]$$

LAWS OF GRINDING FOR TRAVERSED CUTS

From this it is evident that for traversed work:

a Wheel wear increases directly with the work speed

b Wheel wear decreases directly as the decrease in the quantity which we term "traverse factor," which is work speed divided by the square root of the sum of the squares of traverse and work speeds

c Wheel wear decreases directly as square of wheel speed increases

d Wheel wear decreases directly as the square root of the work radius increases

e Wheel wear increases directly as the square root of the feed increases.

The value $\frac{u}{\sqrt{T^2 + u^2}}$ in our expression for index of wheel wear is our traverse factor. Where T is large with respect to u this factor will be appreciably less than unity, but as u increases the reduction in wheel-wearing action is less pronounced.

Table 2 gives values of the traverse factor for a certain machine having the work speeds previously given for draw-in cuts, and the following table (traverse) speeds: 10.02, 14.00, 17.00, 19.70, 26.90 and 32.60 ft. per min. The table shows combinations of speeds giving leads from 2.3 in. upward. As the machine was designed for a wheel $2^1/_2$ in. wide, combinations of speeds giving lesser leads of work are not given.

If we now multiply each of the traverse factors in Table 2 by the wheel-wear value for the corresponding work speed and work diameter as shown in Table 1 (draw-in cuts), we will have a table of wheel-wear values for traversed cuts. These products are given in Table 3.

By assigning certain wheels to specified ranges of wheel-wearing action, we may select the proper wheel through the use of Table 3 in the same way that we did from Table 1. Actually in the case of Table 3 the wheels used would be somewhat softer for the same index figure because the actual depth of cut does not follow the indicated depth (as shown by the feeding mechanism) as closely for traversed work as for draw-in work, and therefore the actual cut is not so deep. This means, of course, that the "spring away" action of the work is more pronounced for traversed than for draw-in work. Careful use of steady rests is therefore very essential.

TABLE 2 TRAVERSE FACTORS

Traverse, ft. per min.	Work, r.p.m.	Lead, in.	Work Diameters 1 in.	2 in.	3 in.	4 in.
10.02	53	2.3	0.810	0.950	0.975	0.985
14.00	53	3.1	0.705	0.883	0.946	0.968
14.00	72.5	2.3	0.805	0.938	0.968	0.976
17.00	53	3.8	0.632	0.850	0.926	0.955
17.00	72.5	2.8	0.730	0.910	0.955	0.974
17.00	87	2.3	0.802	0.935	0.972	0.985
19.70	53	4.4	0.576	0.817	0.905	0.943
19.70	72.5	3.2	0.691	0.884	0.943	0.967
19.70	87	2.7	0.756	0.916	0.961	0.980
19.70	101	2.3	0.802	0.935	0.971	0.986
26.90	53	5.9	0.460	0.720	0.839	0.900
26.90	72.5	4.4	0.574	0.815	0.902	0.942
26.90	87	3.6	0.646	0.860	0.931	0.958
26.90	101	3.1	0.703	0.890	0.950	0.974
26.90	138	2.3	0.801	0.936	0.960	0.982
32.60	53	7.35	0.397	0.655	0.790	0.865
32.60	72.5	5.3	0.505	0.760	0.867	0.919
32.60	87	4.4	0.580	0.815	0.908	0.945
32.60	101	3.8	0.635	0.854	0.927	0.960
32.60	138	2.8	0.748	0.914	0.945	0.977
32.60	167	2.3	0.807	0.936	0.967	0.982

The following wheels are found to be satisfactory for our machine for traversed cuts on mild steel under the assumed conditions:

Wheel Designation		Wheel-Wear Values, Table 3
36 or 46 I	for values up to	.02500
36 or 46 J	for values from	.02500 to .04000
36 or 46 K	for values from	.04000 to .05000
36 or 46 L	for values from	.05000 to .06000
36 or 46 M	for values from	.06000

Use No. 60 grain for hard material and a grade softer; but use no wheel softer than I.

Important Note. These statements of wheel assignment are based upon assumptions of the best machine conditions and most careful operation to prevent any abuse of the wheel. Field practice will usually show harder wheels in use due to conditions which abuse the wheel. Efficiency is sacrificed where such is the case.

PRODUCTION COSTS

If wheel wear were the most important element of production cost, grinding efficiency might be considered on this basis without leading to the fallacy which exists today. As a matter of fact, the wheel cost is almost negligible compared with the other costs, and wheel selection should be based upon the production capacity of the wheel under the given set of grinding conditions, allowing the wheel wear to be as high as is necessary to get a free action without excessive wear (which would cause difficulty in sizing work and the need for frequent dressing). The all-important factor is the rate at which the wheel may be made to cut and still not get out of truth. This affects the grinding time, any reduction of which is of vastly more importance than an increase of wheel wear which may result from such a reduction.

TABLE 3 WHEEL-WEAR VALUES FOR TRAVERSED CUTS

Traverse, ft. per min.	Work, r.p.m.	Lead, in.	Work Diameters 1 in.	2 in.	3 in.	4 in.
10.02	53	2.3	0.01340	0.02240	0.02820	0.03280
14.00	53	3.1	0.01170	0.02080	0.02740	0.05230
14.00	72.5	2.3	0.01820	0.02450	0.03775	0.04390
17.00	53	3.8	0.01050	0.02005	0.02685	0.03185
17.00	72.5	2.8	0.01650	0.02900	0.03720	0 04370
17.00	87	2.3	0.02190	0.03620	0.04620	0.05390
19.7	53	4.4	0.00955	0.01930	0.02620	0.03142
19.7	72.5	3.2	0.01560	0.02820	0.03675	0.04350
19.7	87	2.7	0.02060	0.03540	0.04570	0.05355
19.7	101	2.3	0.02540	0.04185	0.05245	0.06260
26.9	53	5.9	0.00763	0.01695	0.02430	0.03000
26.9	72.5	4.4	0.01290	0.02600	0.03520	0.04240
26.9	87	3.6	0.01760	0.03320	0.04420	0.05235
26.9	101	3.1	0.02220	0.03980	0.05125	0.06185
26.9	138	2.3	0.03470	0.05130	0.06195	0.08500
32.6	53	7.35	0.00660	0.01545	0.02290	0.02885
32.6	72.5	5.3	0.01140	0.02420	0.03380	0.04130
32.6	87	4.4	0.01580	0.03150	0.04315	0.05160
32.6	101	3.8	0.02000	0.03820	0.05000	0.06100
32.6	138	2.8	0.03230	0.05580	0.06095	0.08450
32.6	167	2.3	0.04210	0.06940	0.08800	0.10230

In good practice the volume of wheel wear is approximately a tenth of the material removed (mild steel) during roughing operations. A conservative estimate of the cost of operating a modern cylindrical grinding machine (exclusive of wheel cost) is, say, five cents per minute, including labor at day-rate wages.[1] The useful content of the wheel may be assumed to be such that the wheel is actually worth seven cents per cubic inch. If production could be increased to 2 cu. in. per min. where previously we obtained $1^1/_2$ cu. in. and wheel wear jumped from 0.15 cu. in., say, to 0.25 cu. in. per min., our first cost would be: $(0.05 + 0.15 \times 0.07) \div 1.5 =$ \$0.0404 or 4.04 cents per cu. in. removed. In the second case, $(0.05 + 0.25 \times 0.07) \div 2 =$ \$0.0338, or 3.38 cents per cu. in. removed.

Now the overall production efficiency of the machine based upon all costs involved is indicated by production-cost factors proportional to the earning rate of the machine. In the first case this factor would be: (production) ÷ (cost) $= \dfrac{1.5}{0.05 + 0.15 \times 0.07} = 24.8.$

In the second case, $\dfrac{2.0}{0.05 + 0.25 \times 0.07} = 29.6.$

It evidently will pay to wear the wheel more in order to obtain the higher rate as the overall gain in the foregoing is about 19 per cent. The above assumed values are reasonable and the figures given might be considered as typical. Table 4 gives these production-cost factors, or relative earning rates based upon these costs and the grinding conditions previously assumed in Tables 1, 2 and 3, the variations being due to traverse and work-speed relations only, but with proper choice of wheels in each case. Then, for the machine which we have used as an illustration it is evident that for work of a certain size and a wheel of a certain width there is one speed combination which will utilize the machine to the greatest profit. If we are able to use wheels of the width needed to cover the lead under the best speed-relation conditions, we will obtain the best earning rate of which the machine is capable. If wide wheels are not available, we still have speed-relation conditions which will give very nearly as high a rate for the narrower wheels.

In Table 4 the production-cost factors are given for 1-in. and 4-in. diameters of work only. The factors may also be expressed as earnings per unit of time, or the relative amounts the machine would earn in equal lengths of time under the various conditions as given.

Note that, due to high traverse, a 2.3-in. wheel which earns \$3.68 in a certain length of time when grinding 1-in. work at low traverse and work speeds, will earn \$10.62 in the same length of time when using the high speeds. If the widest wheel (7.35-in. face) be used the machine will earn \$11.70 in the same length of time. The grade of wheel is suitable in each case according to the speed changes. This clearly shows that high traverse speeds cause a corresponding increase in earnings in spite of the necessary increase in work speed.

TABLE 4 PRODUCTION-COST FACTORS

Table Speed, ft. per min.	Work, r.p.m.	Lead, in.	Diameter of Work 1 in.	Diameter of Work 4 in.
10.02	53	2.3	3.68	13.45
14.00	53	3.1	5.16	18.80
14.00	72.5	2.3	4.95	17.85
17.00	53	3.8	6.00	21.00
17.00	72.5	2.8	6.00	21.80
17.00	87	2.3	5.85	22.00
19.70	53	4.4	6.40	23.70
19.70	72.5	3.2	6.80	23.50
19.70	87	2.7	6.84	23.45
19.70	101	2.3	6.75	23.30
26 90	53	5.9	9.05	29.80
26.90	72.5	4.4	9.34	29.85
26.90	87	3.6	9.00	29.00
26.90	101	3.1	9.03	29.10
26.90	138	2.3	9.00	29.15
32.60	53	7.35	11.70	35.70
32.60	72.5	5.3	11.30	34.60
32.60	87	4.4	11.00	33.60
32.60	101	3.8	10.90	33.40
32.60	138	2.8	10.80	33.30
32.60	167	2.3	10.62	32.90

Considering the cost of wheels 7.35 in. wide as compared to wheels 2.3 in. wide, and the relative power required to drive the two wheels, it is very evident that the use of a harder wheel 2.3 in. wide would offset the difference in wearing action without greatly reducing production and that the production of the 7.35-in. wheel is matched by the production of the 2.3-in. wheel using highest traverse and highest work speed.

The most striking conclusion from the above is the fact that in order to use a narrow wheel and get great production the high work speed does not cause excessive wheel wear *due to the relief* on the wheel brought about by the *high traverse speed*. This traverse speed is also necessary to allow the rapid exposure of fresh work surface to the cutting face, making for a highly economical combination.

The foregoing should demonstrate clearly what this new development in the science of grinding may mean to the art as practiced throughout our production shops.

Actual grinding tests upon a machine having the high-traverse feature, and making use of the speeds shown in the table, have conclusively proven the deductions indicated by the mathematical calculations. On mild machine steel (0.15 per cent carbon) over diameters ranging from $^3/_4$ in. to 4 in., production rates as high as 2.00 cu. in. per min. have been easily attained, grinding to limits of 0.0010 in., removing 0.060 in. from the diameter over lengths of from 36 to 72 in.

When machine conditions, truth and balance of wheel, and proper use of steady rests and grinding compound are intelligently and skilfully handled, wheels of 36 and 46 grain size, and grades I to L (Norton system of grading) have been used in these roughing operations. Especially where the feeding is carefully regulated so as *never* to *crowd* the *radial depth* of cut to more than the possible depth of grain penetration (say, not to exceed 0.0015 in. on the diameter) per traverse, it has been found that the wheel face remained sufficiently true to leave a commercial finish of fair degree absolutely free from chatter marks, feed lines or any other imperfections of real or imaginary consequence.

Owing to the fact that in the above the highest work and traverse speeds were used in every case, the grade (hardness) of wheel was increased as the diameter of the work increased. This is in accordance with our formula for index of wheel wear. Instead of considering the work speed and work radius independently, they were in this case tied together by the fact that a constant work r.p.m. was used. The expression for this is as follows:

$$\text{Work speed } u = \frac{2\pi r N}{12} \qquad [5]$$

where r = work radius (inches) and N = r.p.m. Substituting [5] in [4],

$$WW_1 = \frac{0.275\mu}{V^2}\left(\frac{N^2}{\sqrt{T^2 + 0.275r^2N^2}}\right)\sqrt{2fr^3} \qquad [6]$$

Now if V, N, T and f are made constant, WW_1 must vary as the value r appears in the formula, the greatest effect being the $\sqrt{r^3}$ factor and we would expect therefore to use harder wheels as r increases.

Conclusions

The conclusions to be drawn from the foregoing are definite and indicate positively how to arrive at the solution of precision grinding problems, provided one has an intelligent knowledge of abrasive wheels and the usual materials ground.

Greatest grinding efficiency is obtained by the use of the *softest wheels* suited to the nature of the material ground. This efficiency is dependent upon the control of the dimension and speed relations between the wheel and the work so that the individual chip may have the minimum depth for a given volume determined by the maximum allowable radial depth of cut. This means long arc of contact, low work speeds and maximum feeds. With these conditions established, *increase of traverse speed increases production without increase of wheel-wearing action.* Machine conditions must be such as to maintain as accurately as it is reasonably possible the speed and dimensional relations of the wheel and the work.

There is an enormous field for the industrial engineer in obtaining better production at less cost in grinding operations. There is a definite science involved, there is no mystery about it. The proper appreciation of the laws of grinding by machine designers and operators is rapidly increasing and we may expect a constant improvement in the art as a consequence.

[1] The figure of 5 cents a minute as time cost of operation is based upon labor at 75 cents an hour and an hourly burden of \$2.25 an hour (power, investment, rent, heat, light, etc.).

Cloths for Mechanical Uses

The Specific Mechanical Purposes for Which Cloths Are Used and an Enumeration of Their Applications in the Most Important Industries

By JAMES W. COX, JR.,[1] NEW YORK, N. Y.

CLOTHS for mechanical uses are made from practically all the well-known fibers, cotton predominating, with wool, asbestos, silk and linen following in about the order named. Occasionally other fibers are used in cloth for special purposes. Cloth is used for mechanical purposes where it only will function or as a substitute for leather, metal banding, metal cloth, rawhide, sheet metal, wire or wire screen. Cost is usually the principal consideration for substituting cloth for the above materials; also it has been found in many instances that a fabric did the work in a better manner than the original substances, flexibility being a large factor in its adoption.

These cloths can be classified as to specific uses and to different industrial groups. It is impossible in one paper to give every specific use of mechanical cloths. The following tabulation, however, roughly covers their most common uses:

Absorption	Containers	Inking	Pressing
Aprons	Cushion devices	Insulating	Screens
Backings	Curtaining	Jacketing	Sieves
Bagging	Distributors	Laminated materials	Slings
Belts	Drying	Leaders (machine)	Steaming
Binders	Facings	Linings	Straps
Buffers	Fabric bases	Marking	Tapes
Bumpers	Filters	Moistening	Tracing
Cabling	Flame protectors	Packing	Tubing
Carriers	Formers	Paddings	Washers
Cleaners	Gaskets	Partitioning	Webbing
Conveyors	Grips	Patches (repair)	Wicks
Covers	Hose	Polishing	Windings

Practically every industry uses cloth mechanically in some way, those listed below being the largest and perhaps the most prominent consumers:

Aircraft	Conveyor	Mining	Printing
Army	Electrical	Musical instruments	Pumping
Automobile	Engraving	Office machinery	Railroads
Baking	Farm machinery	Oil	Rubber
Beverage	Flour	Packing (mechanical)	Shipbuilding
Candy	Gas manufacture	Paint	Shoe machinery
Canning	Household machinery	Paper	Textile
Chemical	Laundry machinery	Powder	

Specific Uses

Absorptives. Coarse plain-woven jute and cotton cloth are used for this purpose. In either case the material is impregnated chemically so that when put in a machine, room or mine it will absorb gases of various kinds, moisture, etc. Cloth for absorption purposes is generally known as "brattice cloth." Jute was almost universally used until the price mounted; now low grades of cotton and cotton waste are used to a large extent as a substitute.

Belting. Woven belts are made for practically every purpose a leather belt is used for, including conveyors and machine aprons. Woven belting is being used plain, or impregnated with various substances such as tar, rubber and materials of this type. It has the advantages of being more nearly heat-, gas-, moisture- and water-proof and is usually cheaper. Belts of this type are made wholly of cotton, or if excessive strength is required the warp is of camel's hair. In general they are a two- to eight-ply plain fabric made like a webbing and resembling before treatment a heavy, thick, narrow duck.

Belts of canvas or light duck in two-ply and up are also made by stitching the length of the belt every half-inch or so apart. Then this is treated or impregnated in the same way as the solid-woven fabric.

Bindings and Check Straps. Heavy cotton webbing is used on various types of machines for lifting mechanisms. It is used in loop form on automobiles to prevent the too rapid recoil of the springs, also in special patented devices to achieve the same purpose. It is used for check straps on machines, train signals, and in street and railroad cars. Impregnated, light cotton tape is used for making various pipe connections and in electrical wire splices.

Conveying. Cotton duck, from light army to heavy numbered, is used extensively in conveying machinery of all kinds. Camel's-hair, plain cotton and stitched canvas belting is also used either treated or plain, according to the conditions under which the conveyor is run. The widths and weights vary from a cotton webbing for conveying small machine parts, to a heavy double- or triple-width belt for a box, barrel, coal or iron conveyor, etc. In two industries, candy making, and photographic-film making, cotton oilcloth is used on account of its smoothness and ease of cleansing.

Filtering. The filtering or straining of gases, air and liquids is considered under this head, the sifting of solids being taken up under "Sieves." In some cases when the filtration is slow and the pressure great the process is known as "pressing," but the action is identically the same, taking out substances that are not desired.

In the manufacture of some commercial gases a fine plain-woven linen, cotton or woolen cloth is used to take out solid particles of matter which are occasionally present. Fine asbestos cloth is also used when a detrimental chemical action would take place on cotton, flax, or wool. Medium asbestos and cotton cloths are used as smoke screens where cinders are an objection. In a few types of air-filtration installations a coarse cotton sheeting is used to take out the heaviest dust particles as the air enters.

As strainers on the ends of flumes in power-house work coarse open-mesh cotton or woolen cloths are used. They are usually called "flume bags" and are used secondarily to wire mesh which prevents the large pieces of substances getting in the pipes. Cotton strainer cloths are used sometimes in the pipes leading to water filters. They are used in canning establishments for the straining of fruit and vegetable juices and somewhat in factories making soups, sauces, relishes, etc. In cider mills a heavier, more open, and thicker cotton cloth is used for the extraction of the apple juice. It is generally a two- to five-ply yarn, loosely woven fabric, resembling a tire fabric in many ways with the exception of the tightness of the weave. This type of cloth is also used in the preliminary straining of other fruit juices.

The filtering of liquid chemicals is done by many kinds of woolen, cotton, linen and asbestos cloth. Some paint makers use a cotton filter cloth also in their manufacturing processes.

In the oil industry cotton filter cloths are used extensively. Crude oil, kerosene, gasoline, benzine, naphtha, linseed oil, cottonseed oil, in fact all kinds of oil, are generally filtered or "pressed" in the making. The cloths range from thin sheeting to heavy duck or multiple-ply hair cloth. When the oil is quite fluid, cotton sheetings and twills are used, and as the viscosity increases the heaviness and thickness of the filtering cloth increase. So next, heavier, thick twills are used, more on the order of a denim, then light duck, army duck and finally the very thick and many-ply cloths where the liquid is forced through by great pressure. These fabrics are of cotton, horse and other hairs. For the heaviest work where they have tremendous strain and pressure, a camel's-hair three- or four-ply cloth is used. These latter types are called "press cloths." In general they are stretched between flanges in a pipe and the oil or liquid forced or "pressed" through them by great pressure, necessitating great strength.

In the case of garbage or sewerage reduction the cloths used are of ply yarns, very open and plain weave. Asbestos cloth is used here to great advantage as it can be cleansed easily by subjecting to fire.

[1] Textile Engineer, 320 Broadway. Mem.Am.Soc.M.E.

Abstract of a paper presented at the Annual Meeting, New York, December 1920, of The American Society of Mechanical Engineers. All papers are subject to revision.

Laminated Cloth. One of the principal uses of laminated cloth is for polishing. Practically always cotton cloth is used, osnaburgs, sheetings and in some cases light duck. Woolen cloth is used in glass polishing to some extent. Laminated cotton-cloth buffers are built up to any desired thickness, stitched, die-cut in circular form and occasionally stitched again spirally. A center of metal or wood is inserted and the polishing wheel is ready for service. This type of polishing wheel is used for polishing leathers, artificial leathers, woods, metals and various kinds of composition materials. It is sometimes used in hat cleaning.

Laminated cotton sheeting impregnated with composition materials of various kinds has been used also in certain types of universal joints. In the textile industry laminated numbered cotton duck stitched, riveted, or both, is used to some extent on looms in the form of lug straps, check straps and pickers. Fine sheeting and light duck laminated and impregnated with composition materials are used for the making of gears. The blank is built up and the gears are cut the same as if of iron, steel or rawhide. Laminated cotton sheeting alternated with a cheap, light woolen flannel is used at times for making pads on which great pressure is brought and where pressed felt would spread and cause an uneven surface.

Laminated cloths are used for packing as noted under that heading.

Packing. Cotton and asbestos cloths, plain and laminated, are used extensively for mechanical packing, in gaskets and in washers of various kinds. The cotton cloth is generally impregnated with composition materials of various kinds and cut in the desired shapes necessary. Asbestos cloth is used both plain and impregnated in the same manner as cotton cloth. It is used for the most part in places where there is great heat. It has this advantage over cotton-cloth packing, but under a tension the latter is generally better. Impregnated jute cloth is also used at times where a cheap packing is desired and no particular strain or heat is present.

A large amount of cloth packing is consumed by prime movers of various kinds: steam engines and turbines; and gas, kerosene, gasoline, and various kinds of oil engines. It is used generally about any power plant. Pipe joints use impregnated cloth packing of all kinds and the consumption of the material in this way is very large. Light army duck and sometimes a light flat duck are used as the outside covering of asbestos and magnesia pipe coverings.

Pads. Under this heading a closely woven cotton sheeting or some times a light twill is used as the covering on inking pads in the printing and engraving industry, particularly on flat-press work. As heretofore described, occasionally a laminated pad made of cotton sheeting and woolen flannel is used on work where there is much pressure against the pad.

Flat ironing machines as used in laundries and homes have a woolen-flannel backing covered with a thick sheeting or light duck as a press pad. This same type of machine somewhat modified is used in tailoring establishments where pressing is done in large quantities.

Polishing. Cloth is extensively used in polishing all kinds of surfaces. Cotton cloths of various types are laminated, sewed or riveted and then cut in disk form for polishing and buffing. They are used for polishing leather, wood, compositions and metals of various kinds, in the shoe industry and automatic shoe-polishing machines. The jewelry and electroplating trades use this type of polisher to some extent. In some instances cotton webbing is used when a heavy pressure has to be brought to bear.

In the making of lenses and various articles of glass, polishing is done by heavily felted woolen cloths, which cover the polishing wheels. These cloths vary from a thin billiard cloth to a thick heavy melton. Woolen cloths are sometimes used in the finishing of hats.

Pumping. Flexible cotton hose, plain or treated, is used very generally in pump connections for gases, air and liquids, especially in industries where a portable pump is necessary. The number of uses is legion and the following are fair examples of its very wide application:

a For gas work, in the handling of oxygen, nitrogen and most commercial gases

b For air use, in the portable vacuum-cleaning outfits on wagons and automobiles, on house, factory, and office cleaners, the connections on compressed-air drills of all kinds, connections on sand-blast cleaning outfits, and on outfits for pumping air to divers

c For combination air and liquid pumps, in the connections for various types of atomizers, spraying devices, etc.

d For liquids, in the connections on water pumps of all kinds; e.g., gasoline motors, fire engines, mine pumps, etc. On spray-painting connections and pumps of that type

e For liquids mixed with solids, in the connections for contractor's pumps, dredge pumps, bilge and boat pumps of different kinds, filtration and sewerage pumps, etc.

Sieves. Cloths of various kinds are used as sieves. The finest is known as silk bolting cloth and is a gauze-type fabric varying from about 20 meshes to the inch up to 200 for the very finest. This is made up to about forty inches in width and is used for sifting flour and any substance which has to be used in very fine powdered form as chalks, paint bases, chemicals, etc. Sieve cloths are made also of linen and cotton in various meshes and weights for not such fine work and where the silk cloth has not the required strength. The weave is practically always plain and the yarns fine.

Treated Cloth. Cotton cloth in the form of sheeting, duck, belting, webbing and tape is used extensively as backing for different types of impregnated fabrics, cloth made of other fibers being rarely used. The treated fabrics may be divided in the general classes of rubberized goods, oilcloths, artificial leathers, insulating materials, impregnated laminated cloths, and semi-transparent sheeting. They can best be described in this order.

Rubber-treated cloth is perhaps most used. Tires consume a large amount of sheeting and a special fabric. Belting and webbing are used for conveyors, belts, and straps. Sheeting and duck, plain and laminated, are used for packing gaskets and washers. Sheeting and duck are used for printers' blankets, bolster aprons on machines for removing hair from hides, paper machines, electric separators and various other purposes. Tubular fabrics are used for hose, tubing and sleeve work.

Sheeting and duck made into oilcloth are used in various ways. As a conveyor apron on office duplicating machines, as aprons on paper-mill machinery, as backing on the drums used on a tapestry carpet loom which prints its own filling, and as a conveyor on one of the machines used in fur-hat making. Oilcloth as belting or as webbing is used as a conveyor under certain circumstances where a smooth surface is desired. Its use in photographic-film manufacture and candy making are good examples of this. Oilcloth can in general be used to a great extent in places where a rubber-treated cloth is used.

Artificial leathers are a more recent development and have just started to prove their practicability in industry. So far their use for mechanical purposes is practically nil.

Treated cloths for insulation are described under the heading Electrical, and laminated treated cloths are discussed under the headings Polishing and Laminated Cloth.

Semi-transparent treated cloths are used for shades, light filters, and in tracing cloth for mechanical drawings. The cloth used varies from a $4^1/_2$-yd. cotton sheeting for shades down to a very fine linen for tracing cloth.

Wicks. Cotton webbing and in a few cases soft, thick flat duck are used on machinery for purposes of a wick to convey various kinds of liquids to a certain point. Soft webbing is used in heater appliances for the conveyance of gasoline, kerosene, and various oils to be burned. It is also used in moistening, oiling, gumming and inking machines of various types for conveying the liquid slowly to a certain point or surface.

Industrial Groups

Aircraft. This heading is readily divided into three classes: aeroplanes, balloons and dirigibles. On aeroplanes cloth is used in all ways common to the gasoline motor, as described under the heading Automobile. The wings use cloths of silk, linen or cotton

or combinations of these, and the fuselage is sometimes cotton-cloth-covered. Around the gas tank is often found a thick layer of rubber covered with cotton cloth to prevent incendiary bullets from igniting the gasoline. The straps used on the seats are often of cotton webbing in place of leather. The grip of the steering lever is often cloth-covered. Balloons use silk linen and cotton cloth for the bags. Dirigibles use the same type of cloths for the bags and body coverings.

Army. The cartridge carriers for automatic rifles and machine guns are metal or a combination of cotton webbing and canvas. The best types of the latter are woven as a part double cloth separated canvas and part webbing. In this manner is woven on one machine the belt in its entirety with pockets and flat spots as desired. Other carriers are made by stitching two webs or two layers of canvas. The slings and strappings for almost all guns are now cotton webbing in various widths and weights. The straps on gun carriages, wagons, tanks, tractors, etc., are practically all cotton web. Silk cloth is used for powder bags. It is generally a plain-weave, roughly made, silken fabric of coarse yarns spun of silk waste.

Automobile. The automobile is a very large user of textile products for mechanical purposes. On the motor, treated-cotton or asbestos-cloth packing, gaskets and washers are used. The fan belt is often either a plain cotton webbing, treated webbing, or an endless belt made by cutting cotton cloth on the bias, building up two to four layers of same and then rubberizing. In this way an endless belt is made which has good wearing qualities. Asbestos wrapping is often used around the exhaust manifold. Practically all water-circulating systems, whether pump or thermostatic, use a rubber-impregnated cotton hose.

Asbestos cloth has been used as a facing for clutches. Asbestos webbing is used for brake linings, plain, or more often with a wire warp and asbestos filling. Plain, thick cotton webbing is also used as brake linings on the cheaper cars. Foot-pedal grips are usually canvas-backed, rubber-treated cloth. Door straps are of heavy cotton webbing, plain, rubberized, or made into artificial leather.

On a certain type of cheap car a thick, narrow cotton webbing is used in the transmission. Cotton webbing in various widths and weights is used for plain check straps on the axles and for special devices for preventing too rapid recoil of the springs after going over a rough spot in the road.

In the electrical system impregnated silk or cotton cloth and cotton and asbestos tubing are found on the generator, motor, magneto, transformer coil, distributor and wires. A treated cotton sheeting is universally used for covers on the steering connections, magneto distributor, springs, etc. In the making of wheels, particularly a certain type of truck wheel, cotton canvas or duck is used. It is placed as a cushion and fitting device between the spokes and the felloe.

The automobile tire consumes a tremendous amount of cotton cloth annually. Plain tire fabric, cord fabric, breaker-strip cloth, and lining are so well known as to need no mention in this paper. Blow-out patches of a rubberized cotton fabric and tire-tread covers, used mostly in Europe, are usually a cotton-canvas backing reinforced in various ways. In the manufacture of tires a cotton sheeting is used in the mold.

Bakeries. The majority of cloth consumed is heavy duck, principally "00" weight. It is used as conveyor aprons in the ovens, mixers, conveyors and wrappers in the most modern up-to-date bakeries. Some webbing is used in the same way. Heavy sheets of asbestos cloth act as heat protectors in the ovens. When flour or other ingredients in the making of cake have to be finely sifted, a very fine cotton sheeting or silk bolting cloth is used.

Candy Factories. The same kind of cloths are used in this work as are used in bakeries, with the exception that some of the conveyor belting is of oilcloth, in order to have a smooth surface easily cleansed.

Chemical Work. Cloths of silk, cotton, linen, wool and asbestos are used in different ways in this industry. They are used principally for sieves and filters. Most of them are of fine, hard-twisted yarns, plain woven goods of various degrees of closeness, though twill weaves and double-cloth fabrics are occasionally used. Cotton goods are used in the greatest quantity and the others about in even proportions.

Electrical. In this industry cloth is used primarily for insulation work and generally impregnated with a composition material of some kind which is a non-conductor of electricity. For fine-wire insulation and very fine machine work silk tapes and cloth are used. As the sizes increase in each case the tendency is to use cotton tapes or sheeting. Abroad, linen tapes and sheeting are used somewhat, but their use in this country is not general on account of the cost and cotton can be substituted. On cable work cotton and asbestos tubing are also used. Asbestos webbing is used in the making of large generators.

In the telephone industry the uses of cloth are similar to those already mentioned; one particular webbing, however, is of interest as it is not believed such a web is used in any way comparable to it. A $1^1/_2$-in. web of wire warp of about forty ends is made with a heavy silk filling to insulate the warp. Diagonally at short intervals across the filling there are open spaces left, leaving the warp bare so that connections can be made. This web is used in switchboard work on board connections.

Engraving. Fine cotton sheeting is used in this industry to cover the inking pads on certain types of engraving machinery. The backing of the engraving press itself is usually a woolen cloth. It is a very fine, closely woven, and closely sheared woolen, very much on the order of a billiard cloth.

Farm Machinery. Army and numbered duck, cotton webbing and belting, packing cloths and hose, plain or treated, are used in farm machinery in varying amounts. They are used on tractors, tractor plows, ditch diggers, harvesters, threshing machines and pump connections of all kinds.

Household Machinery. Vacuum cleaners use treated cloth, usually cotton, as air and refuse bags and in certain types narrow cotton webbing is used as a drive belt. The hose connections are rubberized cotton hose. Some washing machines are partly cotton-cloth-lined to prevent splinters getting into the clot' Narrow cotton webbing is used for driving belts. In certain '' ds of carpet sweepers a rubberized narrow webbing is used as ba. .s or rims to drive the brush rolls. Some mechanical mops use loosely bound laminated cotton cloth, generally a low-grade sheeting or osnaburg. On mechanical ironers cloths are used in the same way as in the laundry industry.

Laundry Machinery. Cotton or woolen cloth is used quite extensively on this machinery. The principal place, perhaps, is on the rolls of a cylinder ironing machine. These rolls are of metal. First is wound a cotton sheeting; next, many layers of what is termed laundry flannel until a good cushion backing is formed. This flannel is a heavy, straight or broken twill, all-woolen blanket. It is of a coarse wool and heavily napped to get the maximum cushion effect. On top of this flannel is wound a covering of light duck, usually about a No. 12.

On flat press ironers, resembling an old ironing board, two or three layers of the woolen flannel are used, covered by a couple of layers of cotton sheeting. On the starching machines a very open-mesh cotton cloth is used as a conveyor apron. It is made of about eight-three's yarn counting about eight to twelve warp threads and picks to the inch. On other machinery where conveyor aprons are needed, duck is used but heavier than on the ironing machine. In general the duck is a No. 4, 5, or 6. Woolen strainer aprons or cotton sheets are used to some extent to prevent the cloths from touching the inside of the extractors. These are any old cloths available. In the washing machines or kiers where family "wet wash" is cleansed, open-mesh bags are used to hold the cloths, in order to keep each lot separate as they turn over in the machine.

Musical Industry. Both cotton and woolen cloths are used in the manufacture of pianos, inasmuch as felt will not cover every purpose. These are used in the actions and in the keyboards. In piano players cotton webbing also is used for belts and treated cotton cloth in the bellows. In organs cotton strapping is used, treated cotton cloth for bellows and, in case of mechanically driven organs, cotton belting for drive belts. Motor-driven music boxes use webbing for belts.

On a few of the best-made phonographs a woolen cloth is placed

on top of the metal plate holding the record while being played. This replaces pressed felt. The cloth used for this is very much like a thick, coarse billiard cloth. Heavy cotton sheeting or light twills, drills or flannel are used in the manufacture of the record itself.

Office Machinery. The equipment of most business offices includes typewriters and adding and bookkeeping machines. These all require an inked ribbon for their operation and here a fine textile product is used. It is a cotton cloth made of very fine combed yarns, plain weave and generally from 80 to 100 counts each way. It is split lengthwise, gummed at the edges, inked and wound on small spools ready for use. On the stenotype machines there are also ribbons of this character.

On some adding machines, bookkeeping machines and dictaphones there are belts for driving them by electric motors and these are in most cases fine, narrow cotton webbing. Cotton sheeting and flannel are used in the manufacture of the record for the dictaphone. On duplicator machines of various types the conveyor aprons used is a cotton-back oilcloth.

Paper Industry. This industry is one of the largest users of textile products, and is entirely dependent on them, as contrasted to other industries where the textile product may be only an aid in producing results. The fabrics used are made of wool or cotton and are called woolen or cotton "felts," as the case may be. A pressed felt was originally used for the purpose and the name has remained although the product has changed to a woven piece of goods. Woolen "jackets" are also used. These are tubular woven cloths, for shrinking on steel rolls hereinafter described.

The first machine in the paper industry on which a fabric is used is the pulp machine. A thick, open-mesh, plain-weave, heavy, endless woolen fabric takes the stock from a tub and deposits it in layer form on a cylinder from which it is afterward cut in the form of sheets.

On paper-making machines, as the paper stock comes from a revolving wire screen, it is deposited on an endless woven "felt" and by this "felt" is carried through iron press rolls on which is shrunk the heavy woolen "jacket." In this manner the water is squeezed through the "felt" and the thin film of stock or partly formed paper is left on the top of the moving cloth. It is carried through numerous pairs of jacketed rolls and by thicker and finer "felts" and finally is formed paper.

The jackets are tubular two- to five-ply woolen cloths, very closely woven, and felted very hard. They are fulled down to a size less than the roll circumference, and sheared closely; then wet, stretched and placed on the roll. When dry they are so tight they are practically a part of the roll and form an excellent cushion.

The woolen felts mentioned above on which the paper is formed vary from a light, thin, open, well-napped blanket to a close, soft, thick cloth much on the order of a very heavy overcoating. They vary in degrees of openness, thickness, nap, etc., according to the conditions under which run. Double-cloth woolen "felts" having the back cloth a flat, smooth, hard-felted surface and the face cloth of hard yarns, are used as "marking felts," to make a special design on the paper after it has left the regular forming felt. "Carrier felts" of coarse, heavy woolen yarns, heavily fulled, are also used at times to convey the paper from one set of rolls to another.

With the paper formed but wet, it is delivered to an endless cotton "felt," which carries it around many steamed-heated cylinders until dry. The cotton drier "felt" is a very thick heavy duck. It is usually a three- to eight-ply cloth, each ply averaging as heavy as No. 4 duck. The weight, thickness and yarns used depends on the conditions under which it is run.

Heavy cotton webbing or doubled duck, impregnated with rubber, is used as a guard on each side of the wire screen which delivers the stock to the "felt." This cotton rubber-covered strip is called "deckle strap." Apron conveyors used between the wire screen and first woolen "felt" are made from cotton cloth or duck either rubberized or made into oilcloth.

Printing. In the printing of textiles, whether silks, linens, cottons, woolens or carpets, cloths are used in three ways. The cylinder which operates against the printing roll is first wound with a linen or linen and woolen lapping. The linen lapping gives a backing to the roll and is used on account of its strength. It is a plain-weave, tightly woven fabric. When the linen and woolen lapping is used, the warp is linen and the filling wool. This gives the requisite strength and more cushion. Stretched around this cylinder to another roll, is an endless belt, a sort of woolen jacket, which being next to the cylinder lapping gives the cloth being printed a cushion to work against. This woolen belt is a two- or three-ply, very close, heavily felted cloth, woven endless usually to get a smooth no-lap effect. Under certain conditions of printing a partially cotton or a rubberized cotton cloth is used in place of a woolen. In printing filling yarn on a tapestry carpet loom of a certain type a cotton-backed oilcloth is used on the drum. The third place where a cloth is used in this kind of printing is for a leader to carry the cloth to be printed into the machine. It is called the "backgrey" and is a heavy, closely woven cotton sheeting. No matter how many cylinders or printing rolls are used the principle is practically the same.

Narrow fabrics such as ribbons, tapes, fancy straps, suspender and other webbing are printed in practically the same manner. This same method is also used in printing wallpaper. In rotary printing presses for printing newspapers, magazines, and other big work the principle is the same, the difference being in the method of application. This is likewise so in rotary engraving work, the cloths in general being the same.

When flat printing or engraving is done, however, a cotton-sheeting-covered pad, a heavily felted light woolen, or a laminated cotton cloth and flannel backing are used. When inking is done by pad the covering is cotton sheeting.

Railroad Work. Cotton hose, usually treated, is employed for practically all airbrake connections on cars of all types. Also in steam and water connections for cars, roundhouses, stations and shops. Some parts of signaling systems use cotton webbing of different widths. On the individual electric car-lighting systems the generator is often driven by a rubberized cotton belt. Webbing in general is used as slings, straps, etc., in railroad-shop work. In steam packing for locomotives cloth is used in general as on a stationary engine. On electric locomotives insulating cloth is used as described under the head of electrical work.

Shipbuilding. The building of ships consumes much cloth in a mechanical way, not to mention the tons of duck used non-mechanically. It is used as cotton and asbestos packing in engines, turbines and pumps, pipes and pipe covering. Flexible cotton hose is used with certain types of ship pumps and it is also used for dredging sleeves for certain types of dredge pumps. Heavy cotton webbing is being gradually introduced to take the place of ropes where a flat surface is preferable to a round one; this is particularly advantageous for ship cranes in loading and unloading light cargo.

Shoe Industry. Wide cotton numbered duck is used on the shoe machines which form the box toes and heels of ordinary shoes. It is used as a forming agent for the parts of the shoe mentioned. Light 12 to 16-oz. duck is also used as backers or formers on other machines. Laminated cotton cloth in the form of buffer wheels is used for polishing.

Textiles. In the manufacture of textiles, cotton, woolen, jute, camel's-hair, linen and asbestos cloths are used. These are so familiar to every engineer in the textile industry that no descriptions of them are necessary; therefore a tabulation only is given in order to have them in proper form. Cotton is used most extensively, approximately 80 per cent of the poundage being of that fiber:

a BELTING. (Cotton or camel's hair, plain or treated):
- Main drives
- Machine drives
- Within machine drives
- Narrow conveyors.

b CARD CLOTHING. (Linen, cotton and wool):
- Backing for various types of card clothing

c CLEARER, SLASHER AND ROLLER CLOTHS. (Wool and cotton):
- Cotton, woolen and worsted work

d COTTON DUCK:

1 Aprons for:

Automatic feeds	Driers	Openers
Blamire feeds	Dusters	Pickers
Camel's-back feeds	Fiber softeners	Scouring machines
Carbonizers	Fur depositors	Take-up rolls
Conveyors	Gill boxes	
Crosser formers	Loom beams	

(*Continued on page 220*)

Phases of the Transportation Problem

Discussion on Motor-Truck Transportation, Government Operation of Inland Waterways, and the Proposed Plan for Handling New York City's Freight and Passenger Traffic

OF THE six papers presented at the sessions on Transportation, held in connection with the 1920 Annual Meeting of The American Society of Mechanical Engineers, three have already been published in the January issue of MECHANICAL ENGINEERING, namely, Railroad Transportation, by Daniel E. Willard; Feeders for Railroads, by Charles A. Morse; and Railway Terminals and Terminal Yards, by Col. William Barclay Parsons. Other papers presented were by Gen. Frank T. Hines on the Government and Inland Waterways, by Francis W. Davis on Motor-Truck Transportation, and by Gustav Lindenthal on the Transportation and Terminal Problems of New York as Affected by the Hudson River. Summaries of these latter are given in what follows, together with an abstract of the written discussion on Transportation offered at the meeting by J. R. Bibbins.

MOTOR-TRUCK TRANSPORTATION

By FRANCIS W. DAVIS,[1] BUFFALO, N. Y.

IN THE short period of twenty years, motor highway transportation, in capital invested and diversified fields of application, has reached the point where it is warranted in seeking counsel with its elder brothers in transportation. Except for certain specialized services the motor truck will never replace waterway and railway transportation, nor be related to them in other than a supplemental capacity.

The problem has three main aspects: (1) The field of truck transportation; (2) the present status of truck transportation; and (3) the improvement of truck transportation.

The Field of Truck Transportation

In cheapness, capacity and low operating costs, waterways, where available, present the most economical form of transportation, especially for bulk material. There is and can be but little competition between waterways and the motor truck.

It is in the "short haul" and at terminal points that the railways are at greatest disadvantage, both as to service rendered and to their own earnings; and it is here that motor transportation comes as a help and releases cars for the long hauls where they are most efficient.

Where railroads and motor trucks do compete, as in the short haul, the problem is to determine which is best suited to discharge the service, where the advantages shift from one to the other, and then let each specialize in the field where it is the more efficient and economic.

The ratio of labor required to tonnage handled precludes the competition of motor trucks with the railway on the long haul.

A table given by the author shows the relative cost of shipping by rail and truck for various lengths of haul.

There is another field of service in which the motor truck is not in competition with other forms of transportation, the so-called "combination service." The truck engine, used primarily for transportation, is available for auxiliary purposes and increasing use is being made of it for loading and unloading operations, the driving of winches, cranes, pumps, etc., and for miscellaneous power requirements.

Present Status of Truck Transportation

There are approximately 800,000 trucks in operation. If each of these averages five tons per day for 300 working days per year the total tons moved by truck would be about 1,200,000,000. This is of course only an approximate estimate. There is great need for accurate statistics on motor transportation similar to those available for the railways.

Truck operating costs vary so with conditions that general averages are almost useless as a guide for specific cases.

[1] Engineer, Pierce-Arrow Motor Car Company.

The question of possible increase in size of motor trucks is an economic one. There is no mechanical limitation preventing a considerable increase in carrying capacity, but if the size increases much beyond the present maximum of 5 to 6 tons capacity the vehicle becomes unmanageable, and the inability always to operate at capacity loads offsets the advantages of large-size units. The weight, too, would exceed the carrying capacity of many of present highways and bridges.

The development of the motor truck is intimately related to the rubber tire.

Improvement of Truck Transportation

In 1918, J. E. Maloney, of the State Highway Department of Colorado, in an investigation of the 131 roads which constitute the state highway system of 3827 miles, gave the following conclusions:

> Taking the traffic for the 3827.6 miles, estimated in the tables published in December as 162,926,098 ton-miles, and applying the average cost, as given in the operating costs, of 10.8 cents per ton-mile, will make $17,595,917 per year as the operating cost for the traffic alone.
>
> A saving of but one cent per ton-mile on this traffic would equal $1,629,261 annually, which sum capitalized at 5 per cent would warrant the expenditure of $32,585,200 in the improvements necessary to effect this annual saving.
>
> From a gravel to a paved road there would be an average saving of 1.1 cents per ton-mile, so that an annual traffic of 95,000 or more ton-miles per mile of road would justify an expenditure of $21,000 per mile for the improvement.

If such savings are obtainable in a sparsely settled state, such as Colorado, proportionately greater savings should follow road improvement in the more densely settled sections where traffic is much heavier.

Proper surfacing and foundations are the greatest need. Grades are of very little importance if these are right. It will be necessary, however, to have bridges of ample capacity to take maximum loads.

Both motor transportation and the highways should be protected by reasonable legislation.

In conclusion, railway transportation should and will hold its place for long hauls and for carload shipments where there is direct railway connection to the factory or warehouse of the shipper. Motor transportation will relieve the railroads of the expensive short haul, serve them at terminals, and widen the zone tributary to the railroads thoughout their entire length. It will supplement the street railways and will spread into a wide field where the engine power can be utilized for auxiliary purposes. With the steady improvement of devices for shortening the loading and unloading time there will be a reduction in the use of horses for heavy freight haulage.

The economic limit of the size of motor trucks will probably remain about as at present, although the use of trailers will increase the tons hauled per movement. The use of motor trucks will increase with the general improvement of the highways. The motor industry will welcome sound and uniform legislation, and aid in securing it.

THE GOVERNMENT AND INLAND WATERWAYS

By FRANK T. HINES,[1] WASHINGTON, D. C.

A REVIEW of the experience of the Government in the operation of inland-transportation-service boats during and following the late war discloses that prior to the creation of the Council of National Defense but one comprehensive survey of the possibilities of inland water routes had been undertaken, namely, the Inland Waterways Commission, instituted by President Roosevelt in 1910.

The investigations of this body resulted in the accumulation

[1] Vice-President, Baltic Steamship Corporation of America.

of a wealth of data covering the status and traffic possibilities of our navigable and potential water routes, and its findings were submitted to the readers of public documents in some eight hundred pages.

From 1910 to 1916 but little was done by the Government for the improvement of waterway transportation aside from the routine river and harbor work of the Corps of Engineers of the Army. In the latter year came the forerunner of the present permanent Waterway Bureau, the Committee on Inland Waterways of the Council of National Defense.

Under the pressure of wartime conditions of 1917 this committee presented reports which were instrumental in later developing a definite governmental policy toward waterway transportation.

With the coming of the United States Railroad Administration and the actual coördination under Government control of all public transportation agencies, the waterway problem was forced still further toward a permanent solution. With the previously active competition between railroads and waterways temporarily suspended, there was presented an unprecedented opportunity for testing out on the basis of strict utility the relative merits of water-borne transportation.

An examination of the several phases affecting traffic on water routes revealed conditions eloquent of the demise of waterway transportation. On the Mississippi, upon which millions in federal appropriations had been spent, scarcely a craft was stirring. On the Warrior River, whose principal utility lies in its situation as an economical outlet for the coal, ore and lumber of central Alabama, a similar situation was met. On the New York State Barge Canal an equally discouraginge ondition existed, though due to the process of transference of traffic from the old route of the Erie Canal.

Early in the spring of 1918 the Director General of Railroads instructed that plans be prepared to make a maximum use of these waterways for the relief of wartime freight congestion. Whether physical operations on these routes should be maintained directly by the Government, as were other common carriers at that time, or whether better results could be secured by encouraging and assisting private enterprise, were questions left to the committee for solution.

After several weeks of intense study the committee recommended the former plan, including the acquisition by the Government of all suitable existing floating equipment and the construction of such additional boats as conditions demanded, it being thought that most immediately efficient results could be secured with the Government operating these fleets so that they would be actually integrated with nearby railways and highways.

Concurring in these views the Director General directed the commandeering of all privately owned craft, and set up the necessary organizations in order that operations might commence immediately on these three waterways.

This action resulted in the assembling of a very mixed collection of floating units, many of which were extremely inefficient and in poor operating condition. Nevertheless these boats made possible the initiation of freight movements by water on a scale much larger than had previously been possible.

It was not the purpose of the Railroad Administration, however, to depend on these chartered boats, and at the same time these lines were inaugurated the construction of fleets of larger and better barges and towboats was undertaken, with which equipment it was proposed to conduct more economical and efficient freight transportation.

Building-program estimates were made of the earnings, but as a matter of actual fact these were not realized and the maintenance of the lines by the Government was a hard, up-hill fight.

The routes are today serving as avenues for transporting thousands of tons of merchandise every month, at an average of 20 per cent below our rates for similar hauls. The most important things which the lines are doing are to awaken widespread public interest in the possibilities of waterway transportation, to educate the shipper in the advantages of routing shipments by water, to demonstrate the classes of merchandise best suited for water haulage and the types of boats best adapted, to indicate the necessity for waterway terminals, and to pave the way for a mutually profitable basis of interchange between the railroad and water carriers.

Congress has already appropriated $2,000,000 to be spent within the next year in building necessary terminals. These projects must stimulate similar construction by private capital. Once these individual lines have reached the stage where they are actually producing profits, the physical operation of the lines may well be given over to private ownership on much the same basis as the Shipping Board is disposing of its war fleets. Until that time, however, the money spent by the Government in pioneering the way toward profitable large-scale waterway transportation may be considered as an investment which will in the near future bring splendid returns.

THE TRANSPORTATION AND TERMINAL PROBLEM OF NEW YORK AS AFFECTED BY THE HUDSON RIVER

By GUSTAV LINDENTHAL,[1] NEW YORK, N. Y.

THE transportation of Greater New York has been the subject of study and plans for many years. That part of the problem which has been touched upon less than might be expected from its importance is the transportation needs and facilities for about 2,000,000 population in New Jersey, within a radius of 15 to 20 miles from the City Hall in New York City. That population separated by the Hudson or North River is a tributary to the city life of Manhattan in the same degree as the 2,500,000 population living on Long Island, separated from New York City by the East River.

To the problem of local passenger transportation across the North River, however, must be added the big problem of passenger and freight transportation from seven large railroad systems reaching out South and West over the American continent and bringing in food, fuel and materials for Greater New York on thirty railroad tracks, humming with traffic day and night.

The Hudson River is a barrier which must be crossed daily by 700,000 passengers, 3,000 freight cars and 8,000 to 10,000 vehicles. Of the passengers about one-half come through the tunnels, all the rest of the passengers, all vehicles and all railroad cars come over as they did 80 years ago, on floating equipment along a river front of 12 miles.

If the traffic crossing the Hudson River were accommodated in the same proportion as it is across the East River at least 20 additional subfluvial tubes would be required, costing around 400 million dollars. The cost of a bridge erected at or below 59th Street, Manhattan, where shores are favorable, is estimated at 100 million dollars.

One of the most effective means of distributing the passenger traffic at the Manhattan end of such a bridge would be a moving platform which would intersect every line, in subway, on elevated or on surface, running north and south, to which a passenger might change. Such a moving platform, at a moderate speed of nine miles per hour, would have a carrying capacity of 40,000 passengers per hour in each direction. The moving platform would be a most important and indispensable feature of the bridge across the North River.

The eight heavy railroad tracks connecting with the seven large railroad systems on the New Jersey side can be used alternately for rapid-transit cars or for through trains. If these eight tracks were connected with an elevated marginal railroad extending along the west side of Manhattan and looped at both ends, and if this West Side railroad were connected by a subway two-track tunnel with a similar East Side marginal railroad, the transportation capacity would be 200,000 passengers per hour. There would be on the bridge alone a potential transportation capacity of 500 million passengers per year, not including highway passengers.

The local passenger traffic out to a distance of 20 to 30 miles in New Jersey could be kept separate from through passenger traffic on all the railroad lines by accommodating the through traffic in a detached union passenger station, located close to the New York end of the bridge.

[1] Consulting Engineer.

FREIGHT TRANSPORTATION

The present number of freight cars crossing the North River averages 3000 a day or 15,000,000 tons of freight per year, including coal. This freight traffic as well as the passenger traffic is growing at the rate of over 10 per cent per year. At least 60 per cent of the food for a population of six million is brought on these railroads from the western and southern states. The capacity of the bridge and stations for freight would be sufficient to handle 2000 freight cars per day each way, which leaves a large margin for growth.

In laying out the plans for freight it is expected to have the coöperation of the city authorities, who are especially interested in the building of market halls at short distances from each other where the public can buy fresh food cheaply and with great convenience.

TOTAL COST OF PLAN

The estimated cost of the bridge and the various connecting systems and equipment is as follows:

a Classification yard in New Jersey meadows and approaches to North River Bridge	$ 15,000,000
b Multiple-track high-level bridge over the North River	100,000,000
c West Side Elevated R.R. in Manhattan, 8 tracks, with stations and market halls, 4½ miles long	20,000,000
d Connection with New York Central going north at 57th St	8,000,000
e Union station in Manhattan	30,000,000
f Moving (conveyor) platforms under 57th St	10,000,000
g Power-plant equipment and locomotives	30,000,000
Total	$213,000,000

This is not a large sum compared with the cost of nearly 500 million dollars for subways in Manhattan and Brooklyn for merely local passenger transportation, but which has reached the astonishing figure of 1600 million passengers per year with a gross revenue of 80 million dollars.

REVENUE AND FINANCING

From a thorough investigation for many years, the conclusion has been arrived at that the interests of the public would be best served by a separate terminal organization acting as an agent and trustee of the Federal Government. It is unquestionable that private capital can build and operate this undertaking quicker, cheaper and more efficiently than it can be done with public funds, but the ultimate title to the structure after amortization should be held by the United States Government.

The time for preparing agreements and plans and for the construction of this gigantic work is estimated at seven years. The trustees of the undertaking should comprise the best managers of railroads, of shipping, of warehousing and of finance.

The gross revenue is estimated at over 45 million dollars, which would leave after expenses of operation a net income big enough to meet all fixed charges and a substantial margin for amortization and profit. The incidental benefits in the increase of real-estate values would be experienced on both sides of the river, but the bridge would undoubtedly make of northern New Jersey a new country.

TRANSPORTATION

BY J. R. BIBBINS,[1] CHICAGO, ILL.

TO discuss transportation as broadly as possible, the producing territory of the country should be considered as a drainage basin, with the tonnage gravitating to various destinations. There are two distinct problems, namely, (1) the interstate movement from the districts of origin to districts of consumption; and (2) the transcontinental movement to port.

Illinois is the approximate center of population and Chicago is the major inland gateway. About 25 per cent of the major production of the country and probably of the Mississippi Basin was exported in normal prewar times, mostly to countries north of the Tropic of Cancer. This United States production is to a large extent subject to wide seasonal variations. Whereas at one time of the year there is a continuous procession of loaded trains outward bound, in the months following there is a preponderant movement of homeward-bound empties.

All the traffic is obliged to filter through the various gateways or terminals and much of it through seaboard terminals where the local and export traffic of the seaboard cities must also be handled. Therefore the rail terminals of the country must be called on to handle a large majority of the nation's tonnage, and accordingly their design and operating plan must proceed toward enlargement and perfection in accordance with the growth of the business of the country.

A prewar analysis of this growth indicates:

a Population last doubled in 37 years, since 1883
b Train mileage last doubled in 23 years or increased as the square of the population
c Passenger traffic last doubled in about 13 years or increased as the cube of the population
d Freight tonnage last doubled in 11 years or increased as the fourth power of the population

While this approximate geometric progression must gradually recede or else reach impossible figures, it is nevertheless patent that we are dealing with a profound forward movement which involves the very life of the nation and which should not be permitted to suffer artificial retrenchment.

The tonnage movement of the country does not move in accordance with the minimum cost of transport, but is affected by the following causes:

a Shipping facilities, frequent and scheduled
b Banking facilities for underwriting cargo
c Balanced cargo movements, in and out
d Port-terminal capacity and special facilities
e Established precedent, commerce and transport.

In the terms of worldwide transportation the vector diagram of transport movement is east-west and north-south. At present the resultant is unquestionably north and east. Here indeed is a problem for serious future consideration.

It is a curious fact that not one major railroad trunk line runs direct from the great northwestern producing lands to New Orleans, the major southern watergate. This omission is significant and will probably not be corrected until transportation is conceived as a whole on broader lines and the nation begins to think in world-wide terms rather than in the purely empirical terms of established local precedent.

A comprehensive discussion of national transportation cannot neglect the important factors concerned with international waterways and port terminals. Perhaps no more definite and tangible result can be secured than by concentrating attention on the traffic gateways.

The economic survey has for some years been used in the manufacturing and utility fields. Is there any reason why the railroad should not adopt the same method to perfect the transport organization of the country along perhaps broader and more economic lines than in the past? Such an economic survey would reveal all the invaluable facts and figures in the various movements between origin and destination. In the writer's experience at least one survey has revealed these complete facts for an entire metropolitan port district. For example:

a Terminal organization, relative efficiency and desirable improvements
b Belt lines, yards and interchanges, proper location
c Relation to the city plan
d Coördination of rail, barge and marine operations
e Administration, finance and accounting, best form.

The time seems opportune to ask for some compensation for the economic isolation of the interior and perhaps at the present moment attention might be centered on the question of a comprehensive study of steam and water transport on a comparative basis. But this study will be worse than useless unless it is conducted with the object of ascertaining the complete facts, not only of technical but of economic and equitable nature.

[1] Consulting Engineer, Chief Assistant, Bion J. Arnold, Mem.Am.Soc.M.E.

Test Code for Evaporating Apparatus

Preliminary Draft of the Third of a Series of Nineteen Codes in Preparation by the A.S.M.E. Committee on Power Test Codes

IN 1918 the Power Test Committee of the A.S.M.E. was reorganized to revise and enlarge the Power Test Codes of the Society, published in 1915. The Committee is a large one, under the chairmanship of Fred R. Low, and under its direction are 19 individual committees of specialists who are drafting codes for the different classes of apparatus comprised in power-plant equipment. Below is reproduced the third of these codes to be completed, namely, the Test Code for Evaporating Apparatus.

This Committee will, of course, welcome suggestions for corrections or additions. These should be mailed before April 1 to the Chairman, care of The American Society of Mechanical Engineers.

Test Code for Evaporating Apparatus

Introduction

1 This Code of Tests of Evaporating Apparatus is intended primarily for apparatus heated by steam, such as vacuum pans, or single- and multiple-effect evaporators. The principal use for such evaporators is in the manufacture of alkali, salt, sugar, condensed milk, extracts from chemicals, and similar processes.

Objects

2 The objects of the test should be clearly defined before preparations are made. Some of the purposes for which tests of this character are made are to determine:

(*a*) The adaptability of the apparatus to the material to be concentrated
(*b*) The most feasible and practicable method or methods of operation
(*c*) The maximum and minimum range in capacity of the evaporator consistant with economical operation
(*d*) The efficiency of the apparatus as a whole, and of its several elements
(*e*) Relative capacity and efficiency of the apparatus compared with other apparatus doing similar work
(*f*) The location of losses which may be minimized or eliminated by improved apparatus or better methods.

Measurements

3 The measurements involved in the testing of evaporating apparatus heated by steam will depend to some extent upon the object for which the test is conducted as defined in Par. 2 above. In general, these measurements will include the following:

(*a*) The general data relative to type of apparatus, and principal dimensions as defined in Table A, Items 7 to 20
(*b*) The weight or volume of the liquor before and after each effect, and for the apparatus as a whole
(*c*) The weight or volume of the steam to each effect and to the apparatus as a whole; also to any auxiliary apparatus
(*d*) The pressure, temperature and quality of the steam to each effect; also to any auxiliary apparatus
(*e*) The temperature, specific heat, and specific gravity of the liquor before and after each effect, and before and after the unit as a whole
(*f*) The weight or volume of water evaporated from the liquor
(*g*) The weight or volume of condensing water used.

Instruments and Apparatus

4 The apparatus and instruments required for testing evaporating apparatus will include:

(*a*) Tanks and platform scales for weighing liquor and water, or calibrated tanks, or meters
(*b*) Pressure and vacuum gages
(*c*) Thermometers
(*d*) Calorimeters for determining the quality of steam
(*e*) Hydrometers for determining the specific gravity of the liquors, and degree of concentration
(*f*) Apparatus for analyzing the liquors
(*g*) Barometer
(*h*) Electrical instruments, including voltmeter, ammeter, and wattmeter, if electrical measurements are necessary.

NOTE: For a full description of the use, calibration and accuracy of these instruments and pieces of apparatus, refer to the Code on Instruments and Apparatus.

Preparations

5 The General Instructions, Pars. 4 to 8, should be read, and preparations made accordingly, in so far as these instructions apply to the apparatus to be tested. Take the dimensions of the apparatus and the auxiliaries; note their physical condition; examine for leakages; select and install the testing appliances.

For the heating surface of the evaporating apparatus, measure the surface in contact with the steam, the liquor being in contact with the opposite side.

Where the apparatus is subject to vacuum, examine for leakage of air.

To test for air leaks close up and blank off the apparatus. Pump the air out of the apparatus, blank off vacuum pump, and see if air leaks are noted by decrease in vacuum. Small leaks difficult to find may usually be located by painting the joints and the surfaces, if porous, with a good quality of white lead.

Operating Conditions

6 Determine the operating conditions necessary to conform to the object of the test, and see that these conditions are maintained throughout the test.

Starting and Stopping

7 The pressures, temperatures, densities of liquors, and volumes of same within the evaporator should be the same at the beginning and at the end of the test. The test should be started at the beginning of a commercial cycle where such cycles exist in the operation of the evaporator, and after running the required number of hours it should be stopped at the beginning of the next succeeding cycle.

Duration

8 The duration of the test should depend upon the degree of accuracy demanded by the object for which the test is made. In no case should the duration be less than the regular commercial operating cycle. If the cycles are less than four hours in duration the test should cover at least three complete cycles, and the results of each cycle should substantially corroborate the other two. When the cycles are of four or more hours' duration the test should cover at least two complete cycles and these should be substantially corroborative. Should the operation be carried on in shifts the test should continue at least one calendar day of 24 hours. This length of time should be the duration when the supply of liquor or steam is irregular or intermittent, or when for any reason the regularity of the operation cannot be maintained.

Records

9 The data should be taken and recorded in the manner described in the General Instructions, Pars. 20 to 30. Half-hourly readings of the various instruments will be sufficient, except where there is considerable fluctuation in such readings, in which case more frequent readings must be taken in order to give good averages.

Uniformity of operation may be assisted by the plotting of a chart while the test is in progress, as pointed out in Par. 29 of General Instructions.

10 The data and results should be tabulated in accordance with the form shown in Table A, forming part of this Code, adding items not provided for and omitting items not needed to conform to the object in view. Unless otherwise indicated, the items refer to the numerical averages of the readings which are recorded in the log.

The methods of calculating the results as tabulated, so far as not self-evident, or not sufficiently indicated in the text for the items, are explained in the following section.

Calculation of Results

Liquor Levels (Table A, Item 28). The datum from which

these levels are measured must be so given that it will be possible to calculate the hydrostatic head of the liquor in each effect.

Excess Boiling Degrees (Table A, Item 34). The excess boiling degrees of the liquor in any effect is the difference between the boiling temperature of the liquor in that effect and the boiling temperature of water under the same pressure as that of the vapor in the effect.

11 *Steam to Condenser* (Table A, Item 52). This cannot be measured directly. If a surface condenser is used this item can be determined by measuring or weighing the condensed steam discharged from the condenser. If a jet condenser is used, Item 52 may be calculated from the weight of condensing water and the rise in temperature of the condensing water. The product of these two will give the heat transferred to the condensing water, and this heat divided by the heat in a pound of steam going to the condenser, reckoned from the temperature at which the condensing water leaves the condenser, will give the weight of steam going to condenser. The same item may be determined by taking the difference in weight between feed and discharge liquors in the last effect.

If any retained product is found in the steam to the condenser, this must be taken account of in calculating the weight of steam going to condenser.

12 *Evaporation from Liquor* (Table A, Item 53). This is the sum of the steam to the condenser (Item 52) and the condensed steam drained from the effects, except that from the first effect. [Total of Item 61, except (*a*)].

13 *Liquor Entering* (Table A, Item 56). The weight of liquor entering the first effect is the weight of the feed liquor.

In case it is possible to measure the liquor passing from one effect to the next by pitot tube, venturi tube, or other device, the weight of the liquor entering each effect may be calculated from such measurement, and the temperature and specific-gravity test of the measured liquor. If the condensate can be measured, the liquor entering any effect can be calculated by subtracting the weight of the condensate from the feed liquor, or the liquor entering the previous effect. If it is impossible to measure the liquor passing from one effect to the next, the sub-items of No. 56, except (*a*), had better be omitted, as the calculation of these items is very unsatisfactory.

14 *Evaporation from Liquor in Individual Effects* (Table A, Item 58). The satisfactory determination of the several sub-items of this number, except in the case of a vacuum pan, or single effect, depends upon the successful measurement, or calculation, of the liquor passing from one effect to the next. If the liquor can be measured the evaporation in each effect is determined by taking the difference in weight of the liquor entering and leaving that effect (Items 56 and 57), or by measuring the condensate directly.

15 *Evaporation from Liquor from and at 212 Deg. Fahr.* (Table A, Item 53). This is Item 68 ÷ 970.4.

16 *Self-Evaporation* (Table A, Item 59). Self-evaporation in any effect is determined as follows: Multiply the weight of the liquor entering that effect by the temperature drop between the boiling point in that effect and the boiling point in the preceding effect, and by the specific heat of the liquor. Divide this quantity by the latent heat of evaporation in the effect considered. The result is the weight of self-evaporation.

17 *Heat Contained in Entering Liquor* (Table A, Item 63). This is the pounds of feed liquor multiplied by the temperature above 32 deg. fahr. of the feed liquor, and this product multiplied by the specific heat of the feed liquor.

18 *Heat from Steam Supplied to Entire Apparatus* (Table A, Item 64). This is the sum of the products of the pounds of steam, from Items 42, 43 and 44, multiplied respectively by the total heat, above 32 deg. fahr., in a pound of steam of the pressures and qualities used.

19 *Heat to Pumps* (Table A, Item 65). This is the product of the pounds of steam to pumps, Item 44, by (the heat units in a pound of live steam to pumps minus the heat units in one pound of exhaust steam from pumps corrected for quality).

20 *Heat Contained in Discharge Liquor* (Table A, Item 66). This is the product of the pounds of discharge liquor (Item 51) by the temperature, above 32 deg. fahr., of the discharge liquor, and this product multiplied by the specific heat of the discharge liquor.

21 *Heat in Steam to Condenser* (Table A, Item 67). If the quality of this steam can be obtained this item may be calculated from the weight of steam to condenser (Item 52) and the heat units in a pound of this steam; otherwise this item must be calculated from the heat absorbed by the condensing water; or, pounds of condensing water (Item 62) multiplied by rise in temperature of condensing water [Item 37 (*b*) — 37 (*a*)]. To this must be added the heat in the condensate above 32 deg. fahr.

22 *Heat Contained in the Evaporation from Liquor* (Table A, Item 68). This is the heat in the steam going to the condenser, plus the heat in the condensed steam drained from the effects (except that drained from the first effect: Item 67 + (Item 73 — Heat in condensed steam from first effect).

23 *Heat Contained in Entrained Product* (Table A, Item 69). From the analysis of the steam to the condenser (Item 92) the amount of entrained product is determined. The weight of this entrained product, multiplied by its temperature above 32 deg. fahr., and this product, multiplied by the specific heat of the entrained product, will give the heat in such product escaping with steam to condenser.

24 *Heat Supplied to Heaters* (Table A, Item 70). This is the product of the pounds of live steam to heaters (Item 42) by the total heat above 32 deg. fahr. in a pound of such live steam. To this must be added the heat supplied from exhaust steam, if any. This is the product of the pounds of exhaust steam to heaters (Item 47) by the total heat above 32 deg. fahr. in a pound of such exhaust steam. In determining the heat in the steam the quality of the steam must be taken into account.

25 *Heat in Water from Heaters* (Table A, Item 71). This is the product of the pounds of water discharged from heaters (Item 60) by the temperature of such water above 32 deg. fahr.

In case of more than one heater the heat will need to be calculated for each heater separately and the sum of the several quantities taken.

26 *Heat Supplied to the Effects* (Table A, Item 72). This is the product of the pounds of live steam to the effects (Item 43) by the total heat above 32 deg. fahr. in a pound of such live steam. If exhaust steam is supplied to the effects its heat must be added to the above. Pounds of exhaust steam (Item 48) multiplied by the total heat, above 32 deg. fahr., in a pound of exhaust steam.

27 *Heat in Condensed Steam Drained from Effects* (Table A, Item 73). This is condensate taken from the steam space of an effect. In case of more than one effect this should be passed along to the next effect if possible, where its heat may, in part at least, be transferred to the liquor. This heat is the product of pounds of condensed steam [Item 57(*b*)] multiplied by the temperature above 32 deg. fahr. of such condensate. In case the apparatus has more than one effect the heat must be calculated for each effect separately, and the sum of the several quantities taken.

In case the condensed steam flows from the steam space of one effect to that of the next effect its temperature should be measured at point of leaving the last effect of the series. This temperature, in degrees above 32 deg. fahr., multiplied by the pounds of condensed steam leaving the last effect will give the heat in the total condensed steam drained from the effects.

28 *Heat Discharged from the Effects* (Table A, Item 74). This is the sum of Items 66, 67, 68 and 73.

29 *Apparent Heat-Transmission Coefficients.* The apparent heat-transmission coefficient in any effect is obtained by dividing the total heat transmitted per hour in that effect by the heating surface in that effect, and by the apparent temperature drop. The apparent temperature drop is the difference between the temperature corresponding to the pressure of the heating steam and the temperature corresponding to the pressure in the vapor space of the effect.

The total heat *transmitted* in any effect is not the heat corresponding to the evaporation in that effect. It is less than this quantity by the heat in self-evaporation. The total heat *transmitted* is therefore determined by subtracting from the total evaporation (Item 58) the self-evaporation (Item 59), and multiplying this difference by the total heat (above the temperature of the vapor) in one pound of steam at the pressure and temperature of the vapor in the effect.

30 *Corrected Heat-Transmission Coefficients* (Table A, Item 82). Apparent heat-transmission coefficients, as outlined in Par. 29, may be corrected for

(*a*) Excess boiling degrees
(*b*) Hydrostatic head
(*c*) Both excess boiling degrees and hydrostatic head.

The report should clearly specify which of these corrections have been made.

If a coefficient is to be corrected for excess boiling degrees, the heat transmitted as explained in Par. 29, is to be divided by the heating surface and by the temperature drop between the temperature corresponding to the pressure in the heating space and the actual boiling point of the surface liquor in the effect in question.

If a coefficient is to be corrected for hydrostatic head the total heat transmitted, as explained in Par. 29, is to be divided by the heating surface and by the temperature difference between temperature corresponding to the pressure in the heating space and the boiling point of the liquor at the mid-point of the hydrostatic head. This last temperature is to correspond to a pressure equal to the pressure of the vapor space plus a pressure due to a column of liquor equal to one-half the hydrostatic head.

FINAL REPORT

Evaporative Ratio and Efficiency of Individual Effects

31 *Overall Thermal Efficiency of the Entire Equipment* (Table A, Item 75). This is the ratio of the heat contained in the total evaporation from liquor, to the heat from steam supplied to entire apparatus. Item 68 divided by Item 64, and the quotient multiplied by 100 to give percentage.

32 *Thermal Efficiency of the Effects* (Table A, Item 76). This is the ratio of the heat contained in the evaporation from liquor to the heat supplied to the effects. Item 68 divided by Item 72, and the quotient multiplied by 100 to give percentage.

If the evaporation from liquor in each effect [Item 58(*b*)] is calculated, then these figures, with those of Item 61(*b*), may be used to check the above quantity of heat in steam evaporated from liquor, or to figure the efficiency of each effect, and of all effects.

33 *Thermal Efficiency of Heaters* (Table A, Item 77). This is the ratio of the heat put into the liquor in its passage through the heaters to the heat supplied to the heaters.

Item 50 multiplied by [Item 33(*a*) — Item 32(*a*)] and by the specific heat of the feed liquor.

The above product divided by Item 70, and this quotient multiplied by 100, will give percentage.

Economy

34 *Evaporation Per Pound of Total Steam Used* (Table A, Item 83). This is Item 51 ÷ Item 45.

35 *Evaporation from and at 212 Deg. Fahr. Per Pound of Total Steam Used* (Table A, Item 85). This is Item 54 ÷ Item 45.

TABLE A—DATA AND RESULTS OF EVAPORATING APPARATUS TEST

(A.S.M.E. Code of 1920)

General Information

(1) Date of test
(2) Kind of apparatus under test (vacuum pan, multiple-effect evaporator, etc.)
(3) Location
(4) Owner
(5) Builder of apparatus
(6) Test conducted by

Description, Dimensions, Etc.

(7) Type of apparatus
(8) Dimensions of shells
(9) Material of tubes and tube sheets
(10) Number of tubes in each effect { Length / Diameter
(11) Heating surface in each effect ..... sq. ft.
(12) Number and type of liquor heaters
(13) Number of tubes in each heater { Length / Diameter
(14) Heating surface in each heater ..... sq. ft.
(15) Liquor heating surface in each heater ..... sq. ft.
(16) Type and make of condenser equipment
(17) Condensing surface ..... sq. ft.
(18) Type and dimensions of vacuum and circulating pumps
(19) Kind of liquor concentrated
(20) Characteristics of liquor concentrated

Test Results

(21) Duration of test ..... hr.

Average Pressures and Temperatures

(22) Steam pressure by gage ..... lb. per sq. in.
(23) Barometric pressure ..... in. of mercury
(24) Absolute steam pressure ..... lb. per. sq. in.
(25) Pressure in exhaust-steam line from pumps ..... lb. per sq. in.
(26) Pressure or vacuum:
(*a*) 1st effect ..... lb. pressure ..... in. vacuum
(*b*) 2nd effect ..... lb. pressure ..... in. vacuum
(*c*) 3rd effect ..... lb. pressure ..... in. vacuum
(*d*) 4th effect ..... lb. pressure ..... in. vacuum
(*e*) 5th effect ..... lb. pressure ..... in. vacuum
(*f*) 6th effect ..... lb. pressure ..... in. vacuum
(27) Vacuum in the condenser ..... in. of mercury
(*a*) Corresponding absolute pressure ..... lb. per sq. in.
(28) Liquor levels:
(*a*) In 1st effect ..... inches
(*b*) In 2nd effect ..... inches
(*c*) In 3rd effect ..... inches
(*d*) In 4th effect ..... inches
(*e*) In 5th effect ..... inches
(*f*) In 6th effect ..... inches
(29) Temperatures of saturated steam corresponding to the vapor pressure in:
(*a*) 1st effect ..... deg. fahr.
(*b*) 2nd effect ..... deg. fahr.
(*c*) 3rd effect ..... deg. fahr.
(*d*) 4th effect ..... deg. fahr.
(*e*) 5th effect ..... deg. fahr.
(*f*) 6th effect ..... deg. fahr.
(30) Steam temperatures:
(*a*) Superheated steam ..... deg. fahr.
(*b*) Normal temperature of saturated steam ..... deg. fahr.
(*c*) Temperature of exhaust steam ..... deg. fahr.
(31) Temperature of liquor:
(*a*) Entering 1st heater ..... deg. fahr.
(*b*) Entering 2nd heater ..... deg. fahr.
(*c*) Entering 3rd heater ..... deg. fahr.
(*d*) Entering 4th heater ..... deg. fahr.
(*e*) Entering 5th heater ..... deg. fahr.
(*f*) Entering 6th heater ..... deg. fahr.
(32) Temperature of liquor:
(*a*) Entering 1st effect ..... deg. fahr.
(*b*) Entering 2nd effect ..... deg. fahr.
(*c*) Entering 3rd effect ..... deg. fahr.
(*d*) Entering 4th effect ..... deg. fahr.
(*e*) Entering 5th effect ..... deg. fahr.
(*f*) Entering 6th effect ..... deg. fahr.
(33) Temperature of liquor:
(*a*) Leaving 1st effect ..... deg. fahr.
(*b*) Leaving 2nd effect ..... deg. fahr.
(*c*) Leaving 3rd effect ..... deg. fahr.
(*d*) Leaving 4th effect ..... deg. fahr.
(*e*) Leaving 5th effect ..... deg. fahr.
(*f*) Leaving 6th effect ..... deg. fahr.
(34) Excess boiling degrees of liquor:
(*a*) In first effect ..... deg. fahr.
(*b*) In 2nd effect ..... deg. fahr.
(*c*) In 3rd effect ..... deg. fahr.
(*d*) In 4th effect ..... deg. fahr.
(*e*) In 5th effect ..... deg. fahr.
(*f*) In 6th effect ..... deg. fahr.
(35) Temperatures of condensed steam discharged:
(*a*) From 1st heater ..... deg. fahr.
(*b*) From 2nd heater ..... deg. fahr.
(*c*) From 3rd heater ..... deg. fahr.
(*d*) From 4th heater ..... deg. fahr.
(*e*) From 5th heater ..... deg. fahr.
(*f*) From 6th heater ..... deg. fahr.
(36) Temperatures of condensed steam:
(*a*) Drained from 1st effect ..... deg. fahr.
(*b*) Drained from 2nd effect ..... deg. fahr.
(*c*) Drained from 3rd effect ..... deg. fahr.
(*d*) Drained from 4th effect ..... deg. fahr.
(*e*) Drained from 5th effect ..... deg. fahr.
(*f*) Drained from 6th effect ..... deg. fahr.
(37) Temperature of condensing water:
(*a*) Entering condenser ..... deg. fahr.
(*b*) Leaving condenser ..... deg. fahr.
(38) Temperature of air in evaporating room ..... deg. fahr.
(39) State of weather:
(*a*) Temperature of external air ..... deg. fahr.
(*b*) Relative humidity of external air ..... per cent

Quality of Steam

(40) Live steam:
- (*a*) Moisture in steam ..... per cent
- (*b*) Superheat ..... deg. fahr.
- (*c*) Factor of correction for quality of steam

(41) Exhaust steam:
- (*a*) Moisture in steam ..... per cent
- (*b*) Factor of correction for quality of steam

Total Quantities	Total Pounds	Pounds per Hour
(42) Live steam to heaters		
(43) Live steam to effects		
(44) Live steam to pumps		
(45) Total live steam supplied to entire apparatus (sum of Items 42, 43 and 44)		
(46) Equivalent weight of total live steam from and at 212 deg. fahr.		
(47) Exhaust steam to heaters		
(48) Exhaust steam to effects		
(49) Total exhaust steam		
(50) Feed liquor		
(51) Discharge liquor or concentrated product		
(52) Steam to condenser		
(53) Evaporation from liquor		
(54) Equivalent evaporation from liquor from and at 212 deg. fahr.		
(55) Equivalent evaporation from liquor, from and at 212 deg. fahr., per sq. ft. of the total heating surface in all the effects		
(56) Liquor entering:		
(*a*) 1st effect		
(*b*) 2nd effect		
(*c*) 3rd effect		
(*d*) 4th effect		
(*e*) 5th effect		
(*f*) 6th effect		
(57) Liquor leaving:		
(*a*) 1st effect		
(*b*) 2nd effect		
(*c*) 3rd effect		
(*d*) 4th effect		
(*e*) 5th effect		
(*f*) 6th effect		
(58) Evaporation from liquor in:		
(*a*) 1st effect		
(*b*) 2nd effect		
(*c*) 3rd effect		
(*d*) 4th effect		
(*e*) 5th effect		
(*f*) 6th effect		
(59) Self-evaporation in:		
(*b*) 2nd effect		
(*c*) 3rd effect		
(*d*) 4th effect		
(*e*) 5th effect		
(*f*) 6th effect		
(60) Water discharged from:		
(*a*) 1st heater		
(*b*) 2nd heater		
(*c*) 3rd heater		
(*d*) 4th heater		
(*e*) 5th heater		
(*f*) 6th heater		
(61) Condensed steam drained from:		
(*a*) 1st effect		
(*b*) 2nd effect		
(*c*) 3rd effect		
(*d*) 4th effect		
(*e*) 5th effect		
(*f*) 6th effect		
(62) Condensing water		
(63) Heat above 32 deg. fahr. contained in entering liquor	B.t.u.	
(64) Heat from steam supplied to entire apparatus, including pumps. (Calculated from total live steam)	B.t.u.	
(65) Heat to pumps	B.t.u.	
(66) Heat above 32 deg. fahr. contained in discharge liquor	B.t.u.	
(67) Heat contained in steam to condenser	B.t.u.	
(68) Heat contained in the evaporation from liquor	B.t.u.	
(69) Heat contained in entrained product escaping with steam to condensers	B.t.u.	
(70) Heat supplied to the heaters	B.t.u.	
(71) Heat above 32 deg. fahr. in water discharged from heaters	B.t.u.	
(72) Heat supplied to effects by live and exhaust steam	B.t.u.	
(73) Heat above 32 deg. fahr. contained in the condensed steam drained from the effects	B.t.u.	
(74) Heat discharged from the effects	B.t.u.	

Evaporation Ratio and Efficiency of Individual Effects

(75) Overall thermal efficiency of entire equipment ..... per cent
(76) Thermal efficiency of each effect ..... per cent
(77) Thermal efficiency of the heaters ..... per cent

Capacity

(78) Evaporation per hour from and at 212 deg. fahr ..... lb.
(79) Raw liquor to apparatus per 24 hours ..... gal.
(80) Concentrated product per 24 hours ..... gal.
(81) Apparent heat-transmission coefficients:
- (*a*) For 1st effect
- (*b*) For 2nd effect
- (*c*) For 3rd effect
- (*d*) For 4th effect
- (*e*) For 5th effect
- (*f*) For 6th effect

(82) Corrected heat-transmission coefficients:
- (*a*) For 1st effect
- (*b*) For 2nd effect
- (*c*) For 3rd effect
- (*d*) For 4th effect
- (*e*) For 5th effect
- (*f*) For 6th effect

Economy

(83) Evaporation per pound of total steam used ..... lb.
(84) Concentration product per pound of total steam used ..... lb.
(85) Evaporation per pound of steam from and at 212 deg. fahr ..... lb.

Heat Balance	B.t.u. per hour	per cent
(86) Heat to pumps, heaters, and effects:		
(*a*) Heat from steam to entire equipment (Item 64)		
(*b*) Heat above 32 deg. fahr., contained in entering liquor (Item 63)		
Total = (*a*) + (*b*)		
(87) Heat discharged from heaters and effects:		
(*a*) Heat in water from heaters (Item 71)		
(*b*) Heat in condensed steam drained from effects (Item 73)		
(*c*) Heat in steam condenser (Item 67)		
(*d*) Heat in entrained product (Item 69)		
(*e*) Heat in discharge liquor (Item 66)		
Total = (*a*) + (*b*) + (*c*) + (*d*) + (*e*)		
(88) Radiation and unaccounted-for losses: [Item (86) Total — Item (87) Total]		

Liquor Analysis

(89) Analysis of feed liquor
(90) Analysis of discharge liquor
(91) Analysis of liquor out of each effect
(92) Analysis of steam to the condenser to determine the amount of entrained product

Physical Properties of Liquor

(93) Specific gravity of feed liquor
(94) Specific gravity of discharge liquor
(95) Specific gravity of liquor out of each effect
(96) Specific heat of feed liquor
(97) Specific heat of discharge liquor
(98) Specific heat of liquor out of each effect.

(*Signed*)

E. N. TRUMP, *Chairman* — H. L. PARR,
B. N. BUMP, — L. C. ROGERS,
E. A. NEWHALL,

James Watt International Memorial

The Society's check for 250 guineas, the total of the individual subscriptions received from members in response to the appeal issued by the James Watt International Memorial Committee, has been forwarded to Birmingham, England.

A few late subscriptions are still being received and these will be forwarded in a lump sum later. Any members of the Society who have not yet done so, may still send in their subscriptions to the Secretary and their names will be recorded on the list of individual subscribers and sent to Birmingham as soon as compiled.

Chicago Engineers, Attention!!

The following appears at the head of the editorial page of the Chicago *Tribune*. Evidently the editor of the *Tribune* sees clearly that the development of Chicago is an engineering job and that the solution of the engineering problems he enumerates will result in a bigger, cleaner, more moral city.

THE TRIBUNE'S PLATFORM FOR CHICAGO
1—Lessen the Smoke Horror.
2—Create Modern Traction System.
3—Modernize the Water Department.
4—Build Wide Roads Into the Country.
5—Develop All Railroad Terminals.
6—Push the Chicago Plan.

INDUSTRY'S SUPPLY OF ENERGY

(*Continued from page 166*)

great efficiency, but even in Europe and North America only about one-fifth of the potential power has yet been developed. To that extent only have we succeeded in "borrowing the might of the elements" "for the use and convenience of man," but we may expect our rivers to take on an even larger share of the base load in any power program that seeks to conserve the energy supplies in coal, oil, and men. Of course, even with wisest utilization, coal must again take up the burden as full development of water power is approached, for coal is the world's great source of heat and power, and the largest development of water powers is practicable only with coal power as the dependable "stand-by," ever ready to meet promptly any special demand.

Oil and natural gas are the popular fuels, regarded as highly efficient because they are preeminently labor-saving—easily produced, easily transported, and easily used. As source of power these fluid fuels present a marked contrast with water. Hydroelectric energy is even more easily distributed and used, but water-power development involves large capital outlay and in any national emergency no quick response in water power is possible; the water-power projects planned to meet the power needs discovered in the course of our wartime expansion of industry are even now hardly under way. But when the large necessary investment of labor and material is once made in water power the output of energy continues for generations. Oil and gas, on the contrary, are quickly developed and quickly exhausted. Already we realize that natural gas, the ideal fuel, is a resource so temporary that its use forms merely an incident in industrial progress; it has been a wasted as well as a wasting resource. The sorry lesson we have learned in natural gas may have its value if we apply the truth to our use of oil. Unless we check the increase in the consumption of oil it too will be but a flash in the pan.

If we leave the world point of view for a moment and look at the power problem in our own country we are able to see in more detail the relative position of water, coal, and oil as sources of energy. Millions of horsepower, thousands of billions of tons, and billions of barrels are the measures of our nation's wealth in these three resources, yet no comparison is possible except as we reduce these units to a common denominator—something more expressive of true value, which is their use by man. Indeed, such statistics of quantity are too large to be grasped unless we translate them into some kind of national units.

To compare these three resources, then, we may start with the country's present total power requirements: if we take 50 million horsepower as an average figure for the potential water power of the United States, without storage, we find that if fully developed and if used at the average load factor of today our rivers and streams would just about meet the country's present needs and would supply that amount of power for all time; moreover, with storage and an improved load factor they could provide a considerably increased output of energy to meet the growing demand.

Now if, leaving our water-power resources to one side—indeed we have already left them aside too long, we try putting the whole power burden on our coal mines we are able to make a direct comparison between our coal resources and our potential water powers. There is in the United States accessible and available for future use an aggregate of about 2500 billion tons of coal, not including lignite. Only about one-fifth of this is in the Eastern States, another fifth is in the coal fields of the Central States, and nearly three-fifths is in the Rocky Mountain and Western States. In converting these great reserves of coal into power I did not allow directly for the greater differences in the thermal value of the coals, but instead of figuring B.t.u. and thermal efficiency of prime movers, I reached somewhat the same result by using the best central-station practice of today on the Atlantic seaboard, here in the Central States, and in the Rocky Mountain region. Incidentally, I found myself using a new unit, the horsepower-century, for which the equivalent in eastern coal is 250 tons, in interior coal 300 tons, and in western coal, 350 tons. By applying these factors to our estimates of reserves we get 2240 million horsepower-centuries, 1750 million horsepower-centuries, and 4171 million horsepower-centuries, respectively, or a total of 8161 million horsepower-centuries. I should add that a million horsepower-centuries is seven times the present power output of the United States. So you will see that by adopting the best steam practice of today the present power requirements of this country could be met with coal for 57,000 years, although we know that long before the end of that period the greater depth of the coal mines and their increased distance from market would alone create power demands for mining and transportation that would considerably cut down the amount of power available for other uses.

We measure the petroleum wealth of the United States by billions of barrels—about 5 billion already produced in the last 60 years, and about 7 billion left for the future. Again adopting the best steam practice of today in public-utility stations of Texas and California—a little less than 32 barrels to the horsepower-year—and trying to carry the whole power load of the country with oil alone, we find that the oil reserves of the United States, although measured by billions of barrels, would last only 9 years and 3 months. Without allowing for the fact that steam raising for power is only one of the many uses of coal, these two figures, 57,000 and 9¼ years, are sufficiently impressive to make us fairly receptive to the general truth of Mr. Eckel's statement in his recent book, Coal, Iron and War: "We have just as much real chance of replacing coal by oil as we have of finding enough gold to use it in place of steel."

Costs of Energy

These are comparative estimates of the energy supplies which may be tapped for the use of our own citizens, and before discussing their distribution, we should give a thought to the relative cost in human energy in making these three kinds of energy available. I need not tell an audience of engineers the differences in labor outlay in constructing a hydroelectric plant, opening up a coal mine, and drilling an oil well. Each is an engineering project that requires careful planning and the expenditure of money, skill, and labor, but in widely different amounts. Moreover, the water-power plant ought to last for generations and the coal mine for several decades, but the life of an oil well is measured by a few years. In operation, however, the water-power plant is a labor saver, and the best illustration of this fact is that balance sheet put out by the Alabama Power Company, which compares a large steam plant with a hydroelectric plant operated under the same management and feeding into the same transmission lines. In terms of 1000 kw. capacity it takes 13½ men to run the steam plant and the coal mine tributary to it. And how many does it take for the corresponding units in the hydroelectric plant? One-sixth of one man. The exact ratio is 84 to 1. Another comparison with coal is afforded by the statement that in Mexico one man can produce and transport to market the oil equivalent of the coal that it would take 10 men in the United States to mine. These approximate comparisons of the labor cost of our different energy slaves may well be kept in mind as we plan or the larger use of mechanical power.

As mechanical engineers you are best fitted to grasp the national aspects of this energy-supply problem: you can see in true relations both the layout of the supply and the distribution of the demand. Better production is the country's need just now and you men are production engineers in the broadest sense. But, as you well understand, it is not enough for you and me to see the problems of the day and to understand them—that is simply a matter of our mental capacity—but what about performance? It strikes me that this matter of full utilization goes further than material resources or energy supplies: do we not need to raise our intellectual load factor? Is not there too great a gap between our peak practice and our average load? In a word, the engineer needs to be more of a citizen, or, as Herbert Hoover put it the other day, "Organize the engineering mind for expression in public service."

As the result of experience gained on the Santa Fe system, it is stated that the life of a boiler fired with coal is about 10 per cent greater than that of one fired with oil, while the life of the tube is about 40 per cent higher in the coal burners.

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

Recent Trend in Locomotive Design in Europe

VARIOUS influences are at work in Europe in the matter of locomotive design. There is a general feeling that the efficiency of locomotive operation must be increased, and that what was "good enough" in prewar days when fuel was cheap and labor plentiful, may not be good enough at all today, with things as they are.

Of great importance also is the leaven brought in through a greater familiarity with American design. European railroad men have seen the big American engines hauling immense loads in France, and while they are still prepared to find fault with some of their features at least, as far as they apply to European conditions, they have been quick enough to notice many things that are good.

The two English locomotives described in the following abstracts clearly show the influence of American practice, in addition to which they are of interest also as showing some of the original tendencies of British locomotive engineering.

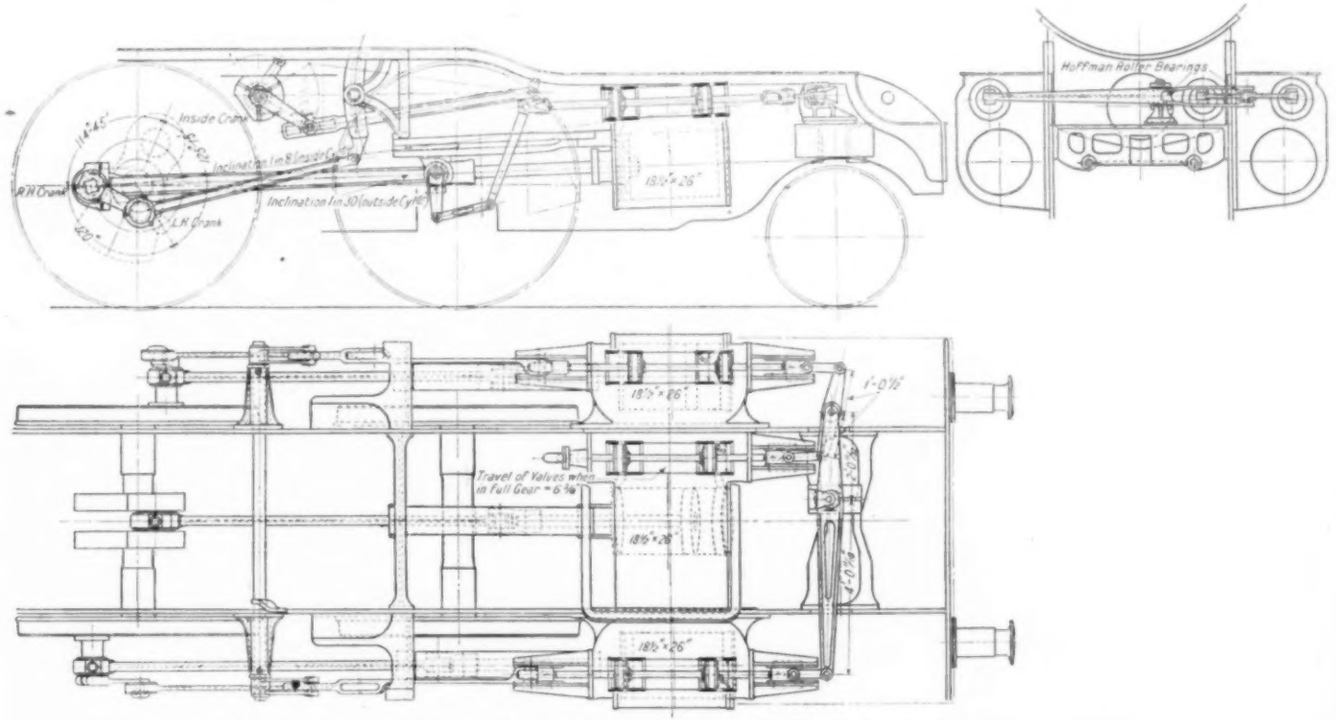


FIG. 1 DIAGRAM OF GRESLEY VALVE GEAR FOR GREAT NORTHERN RAILROAD ENGINE NO. 1000

The German internal-combustion locomotives described in the third abstract do not represent anything strikingly novel, but were considered worthy of attention mainly because the entire art of gasoline-locomotive construction is still in such a state of development that every bit of information is of value.

GREAT NORTHERN THREE-CYLINDER FAST-FREIGHT LOCOMOTIVE

GREAT NORTHERN THREE-CYLINDER FAST FREIGHT LOCOMOTIVE. Features of this locomotive are the novel valve gear with comparatively early cut-off, designed to give high economy through a wide range of power, the use of three steam cylinders, a single plate for the barrel of the boiler, etc. The boiler itself is far larger than has been the British practice hitherto. Ball and roller bearings are used for certain joints in the valve gear, heat-treated chrome steel for connecting and coupling rods, and the locomotive altogether is probably more unlike the standard British practice than any which has yet been placed in service.

So far only one engine, No. 1000, has been placed into service, but nine others are under construction. This engine is a general-purpose one and handles both heavy passenger and heavy freight trains. The barrel of the boiler is made of a single plate $^{5}/_{8}$ in. thick measuring nearly 19 ft. long by nearly 11 ft. 6 in. broad. It has a butt joint with quadruple riveting through two butt straps, the inner strap being much wider than the outer. As a consequence two rows of rivets pass through both the straps and the plate, while the two other rows pass only through the inner strap and the plate. In tests it was found that the ratio of yield point of joint to yield point of material was no less than 93.7 per cent.

In the superheater, which is of the Robinson type, an anti-vacuum or snifting valve is placed just before the chimney and opens downward on the admission side of the header. Steam pressure raises and closes it, but when steam is shut off and the engine is drifting the valve drops and air is sucked through the superheater by the cylinders and discharged up the blast pipe which keeps the elements cool and the cylinders warm.

The cylinder arrangement is shown in Fig. 4. The cylinders are almost horizontal (1 in 30), the inside cylinder alone being inclined at 1 in 8 to clear the leading axle. By placing the three valve chests in one straight line it was possible to use a very simple form of Gresley's valve gear.

The valve motion is shown by diagram, Fig. 1. The two outside cylinders are fitted with Walschaerts' gear. The tail rod of the right-hand valve is linked to a long lever which is fulcrumed on the front transom. This is a lever of unequal arms — 2 to 1. On its left-hand end is carried a floating lever of equal arms, one end of which is linked to the left-hand valve and the other to the inside

valve. The most striking feature about it is the great horizontal lever, over 6 ft. long between centers. It is made of steel and has been carved away to make it as light as possible. At the fulcrum it is fitted with a Hoffman ball and roller bearing, and a bearing of the same kind carries the floating lever. This lever, the only possible feature in the motion that could give rise to any anxiety, has proved perfectly satisfactory. An interesting little question in a gear of this kind is the effect of expansion of the valve rods by heating. Since the position of the two outside rods is fixed by the valve gear, they would transfer the effect of their elongation to the inside valve.

It is claimed that the expansion is so small that only $\frac{1}{8}$ in. has to be allowed for on the central valve and $\frac{1}{32}$ in. on the outside valves, all measured cold. The effect is less than might be expected, because the frames expand as well as the valve rods and carry the fulcrum of the big lever with them. The valve settings are given in Table 1. From this it would appear that a very early cut-off had been adopted for full-gear working, which is intended to permit to secure the full benefit from the use of the three-cylinder arrangement.

In this connection, attention may be called to the Pennsylvania Decapod locomotive described in THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, August, 1917, p. 738. There a 50 per cent cut-off was employed, the purpose being to eliminate the range of cut-offs within which the water rate of the cylinder is excessive, and to make possible an increase in the ratio of cylinder power to boiler capacity. The Great Northern engine has its valves set to give a maximum cut-off of 65 per cent.

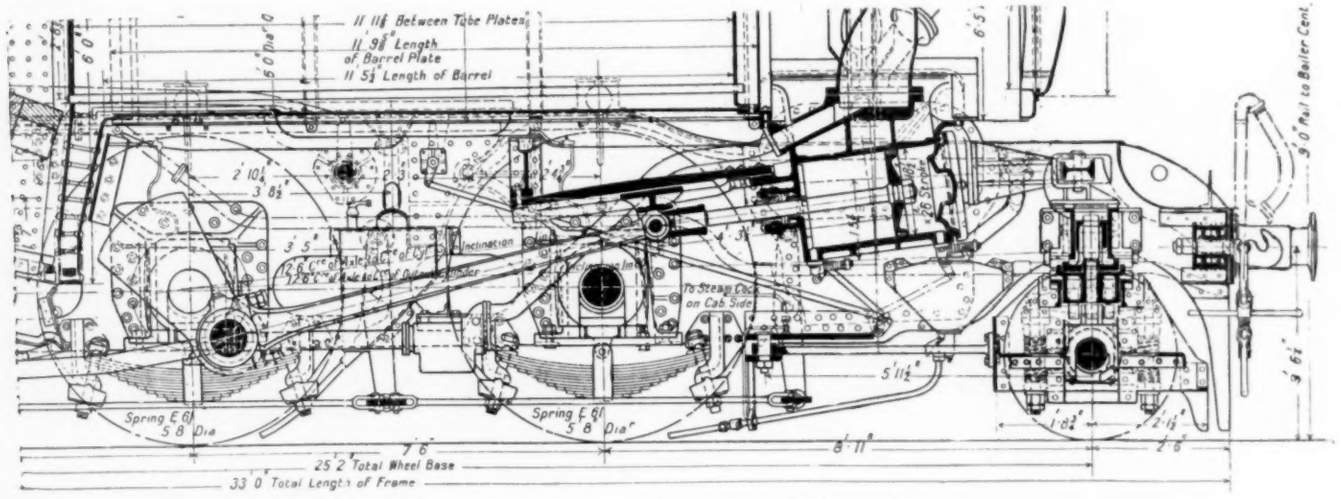


FIG. 2 GREAT NORTHERN THREE-CYLINDER LOCOMOTIVE

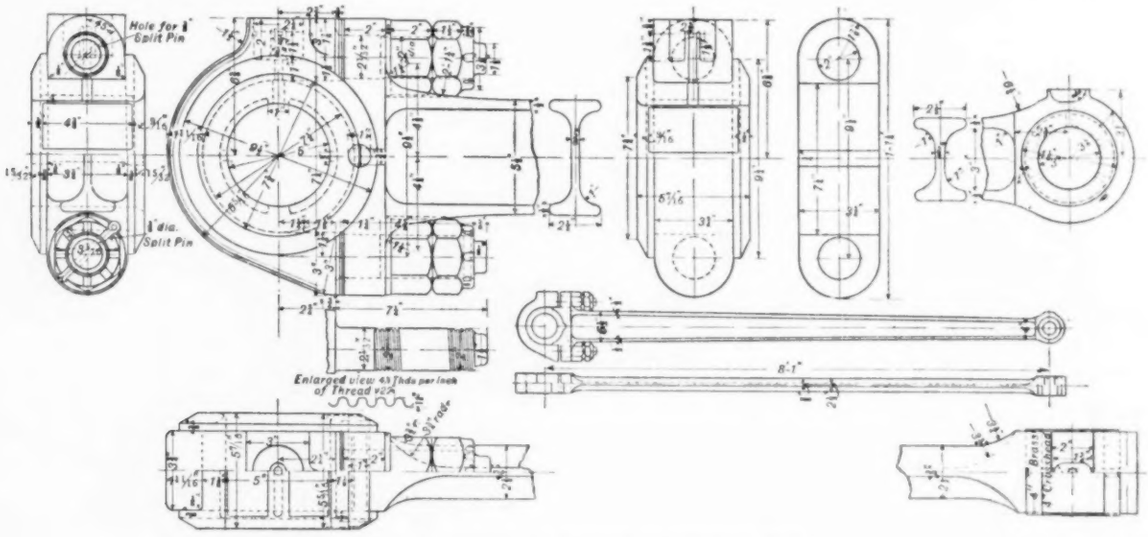


FIG. 3 DETAILS OF OUTSIDE CONNECTING ROD

TABLE 1 VALVE SETTING FOR GREAT NORTHERN THREE-CYLINDER FAST-FREIGHT LOCOMOTIVE

2–6–0 type engine; 8-in. piston valve, 1½ in. lap,—¼ in. exhaust lap; three cylinders, 18½ in. diameter by 26 in. stroke.

FORWARD GEAR

Mean cut-off	Outside cylinder: Travel of valve, inches	Lead F.	Lead B.	Valve opening F.	Valve opening B.	Cut-off F. per cent	Cut-off B. per cent	Inside cylinder: Travel of valve, inches	Lead F.	Lead B.	Valve opening F.	Valve opening B.	Cut-off F. per cent	Cut-off B. per cent
Mid	3 1/4	1/8 F	1/8 F	1/8 F	1/8 F	4.8	4.2	3 3/32	1/8	1/8	3/32	1/8	5.3	4.8
25 per cent	3 17/32	1/8 F	1/8 F	3/32	1/8	25.2	24.3	3 17/32	1/8 F	1/8 F	3/32 F	1/16	25.5	26.0
40 per cent	3 31/32	1/8 F	1/8 F	3/32 B	1/32	39.9	38.2	4 1/16	1/32 B	3/32	1/32 B	1/16 B	39.0	37.3
60 per cent	4 7/8	1/8 F	1/8 F	1/8 F	1	62.3	57.5	4 7/8	1/8 F	1/16 B	3/8 F	1 B	59.1	57.7
Full gear	6 5/8	1/8 F	1/8 F	1 5/8 B	1 3/4	77.4	72.6	6 1/16	1/8 F	1/16 F	1 1/16 B	1 5/16 F	77.4	74.6

BACKWARD GEAR

40 per cent	3 13/16	1/4 F	1/4 F	1/16	1/2 B	40.4	40.1	4 1/32	1/16 F	3/32 B	3/16	1/2	40.4	39.0
Full gear	5 11/16	1/8 F	1/8 F	1 3/8	1 1/16 B	75.2	72.4	6 1/16	1/8 B	1/16	1 5/8 B	1 1/16 F	74.6	70.7

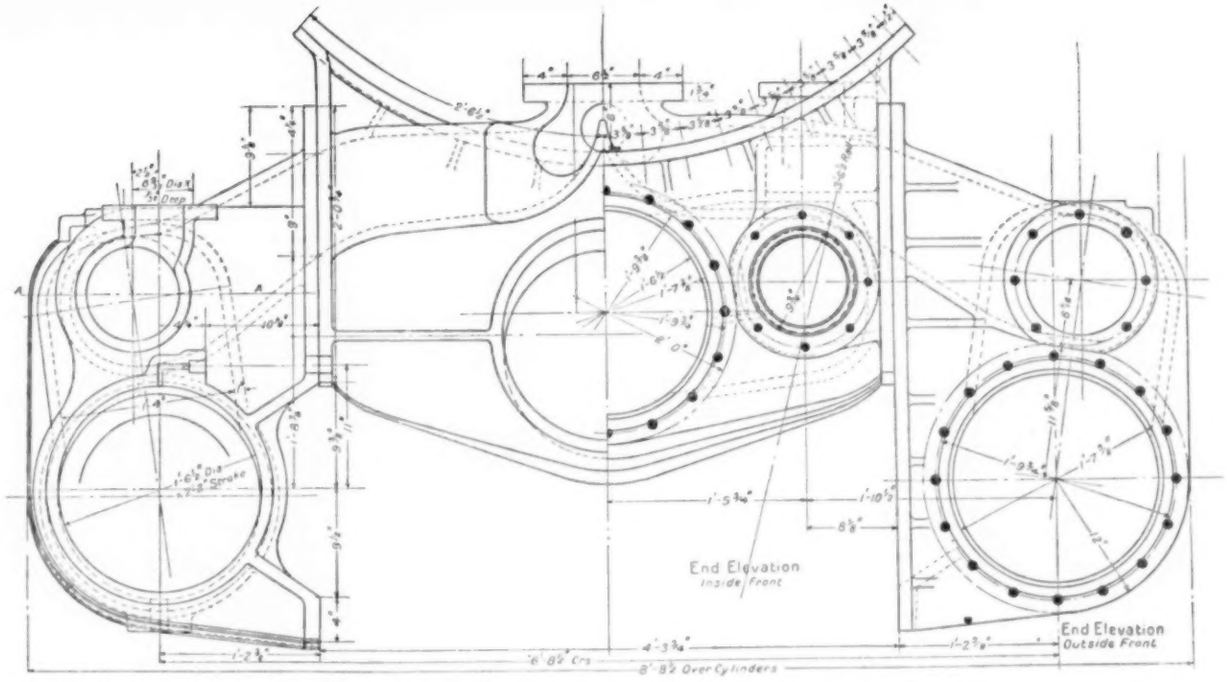


FIG. 4 GREAT NORTHERN LOCOMOTIVE CYLINDER ARRANGEMENT

As it has three cylinders, no very large cylinder diameters need to be used in order to produce sufficient tractive force to absorb a proper percentage of the adhesive weight.

Fig. 3 shows the details of an outside connecting rod made of heat-treated chrome-nickel steel. The weights for the rods are as follows: Outside connecting rod, 295 lb.; inside connecting rod, 347 lb.; coupling rods, 471 lb. The following observation may be of interest: When chrome-nickel rods came back to the shop after heat treatment, it was noticed that they were strongly magnetic in the middle, but not at all at the ends. Furthermore, when the magnetism was examined, it was found that it was positive in the center and negative at the ends. A further investigation has shown, however, that this peculiarity was due to the fact that the rods had been handled by a lifting magnet of the familiar annular form.

In further reference to the boiler, it may be mentioned that the cross-stays above the firebox are carried by brackets riveted to the wrapping plate, and that thirty-two superheater tubes are used.

Particulars given by E. C. Poultney regarding the experience with this engine would indicate that the engine has given great satisfaction in most respects. This part of the article, however, is not suitable for abstracting. (*The Engineer*, vol. 130, no. 3392, Dec. 31, 1920, pp. 634–635, and one 2-page plate. Compare also May 7, 1920, pp. 466–472, illustrated, *dA*)

MIDLAND DECAPOD LOCOMOTIVE

MIDLAND DECAPOD LOCOMOTIVE. Fig. 5 shows a 10-wheel coupled banking engine placed by the Midland Railway, England, for service on the Lickey Incline.

Particular attention is called to the inclination of the cylinders, which apparently is coming into favor in England. Tests made in that country have shown that moderate inclination of the cylinders is disturbing only at very low speed.

In the Midland Decapod the evaporative surface in tubes is 1560 sq. ft. and in the firebox 158.25 sq. ft. The superheater area is 445 sq. ft. and the grate area 31.5 sq. ft. The tractive effort at 85 per cent boiler pressure is 43,312 lb.

In connection with British locomotive development generally might be mentioned the heavy tank engines recently placed in service by the Metropolitan Railway. The wheel arrangement, which is 4-4-4, gives a fixed wheelbase of 7 ft. 9 in., and enables the engine to take yard curves of only 4.5 chains radius. The total weight on the coupled wheels is 39 tons, and on each truck 19 tons, making 77 tons in all in working condition. The cylinders are 19 in. by 26 in., the wheels 5 ft. 9 in. in diameter, and the working steam pressure 160 lb. The engines are required to accelerate rapidly and haul trains of 250 tons, which their tractive effort of 17,400 lb. enables them to do. (*The Engineer*, vol. 131, no. 3393, Jan. 7, 1921, pp. 10–11, 2 figs., *dA*)

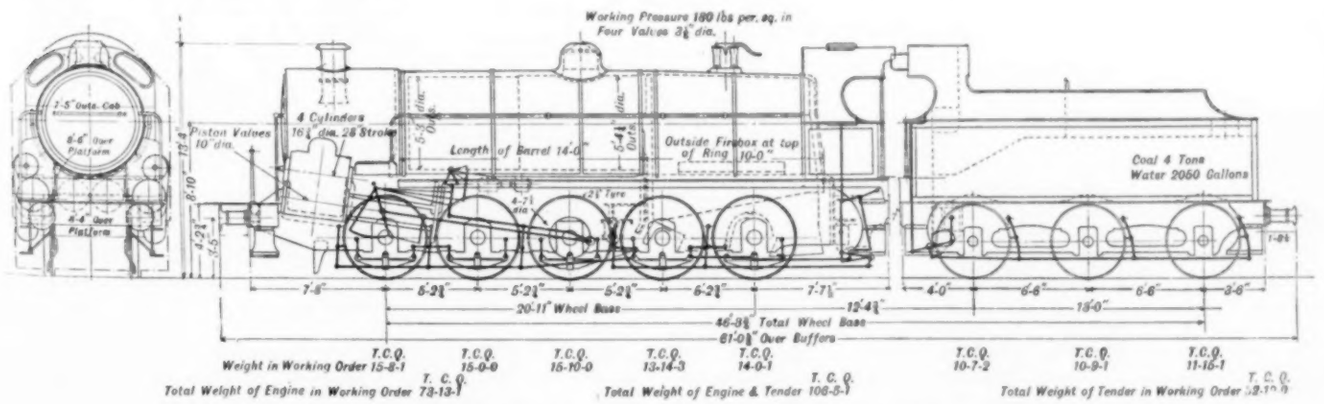

Working Pressure 180 lbs per. sq. in
Four Valves 3½" dia.
4 Cylinders
Piston Valves
Length of Barrel 14'-0"
Outside Firebox at top of Ring 10'-0"
Coal 4 Tons
Water 2050 Gallons
20'-11" Wheel Base
46'-3¾" Total Wheel Base
61'-0¾" Over Buffers
Weight in Working Order 15-2-1
Total Weight of Engine in Working Order 73-13-1
Total Weight of Engine & Tender 106-5-1
Total Weight of Tender in Working Order

FIG. 5 MIDLAND RAILWAY DECAPOD LOCOMOTIVE (BRITISH)

GERMAN INTERNAL-COMBUSTION LOCOMOTIVES

INTERNAL-COMBUSTION LOCOMOTIVES AND THEIR INDUSTRIAL APPLICATIONS. The need for satisfactory means of transportation of light loads at moderate speeds has already been felt for a long time in the mining industry where the available new types, such as fireless, compressed-air, and electric locomotives, have not been found entirely satisfactory. In such work the internal-combustion locomotive has proved superior to the types mentioned in many respects, and in Germany the Deutz Gas Engine Company has led in their development.

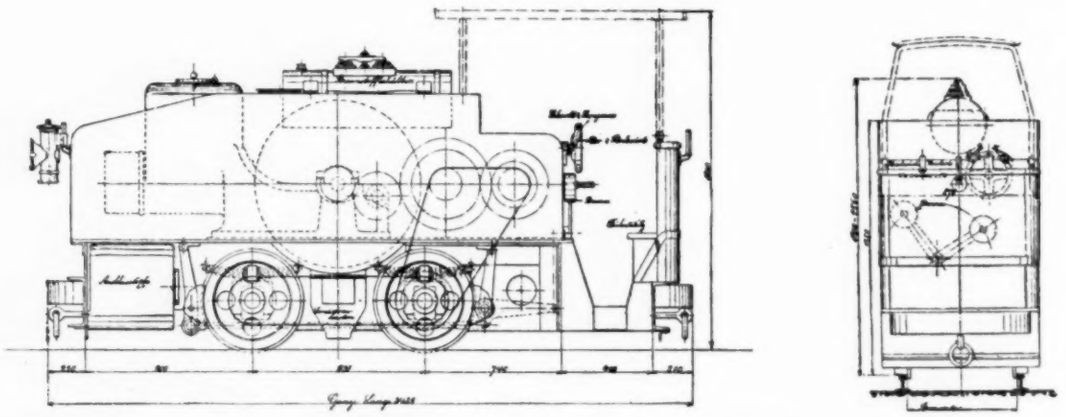


FIG. 6 DEUTZ INTERNAL-COMBUSTION MINE LOCOMOTIVE

Fig. 6 shows side and end elevations of a Detuz internal-combustion mine locomotive equipped with chain drive. The engine is of the single- or multiple-cylinder 4-stroke-cycle type. Cooling is effected by evaporation, some of the water being led to the muffler for the condensation of the exhaust gases, the purpose of this being to render them odorless. This is particularly important in mine locomotives in order to prevent contamination of the air. In particular, in connection with the use of internal-combustion locomotives in mines, it is claimed that the contamination of air resulting therefrom is less objectionable than that consequent on the employment of animals for haulage purposes.

The transmission of power from the engine to the driving axle is carried out either by the chain and gear drive or by gear drive exclusively. If chain drive is employed (Fig. 7), then the power is transmitted from the engine A through the gear wheel R_1 secured firmly on the crankshaft, through the loose intermediate gear R_2 and thence to the gears R_3 and R_4. These latter are loose on the shafts B_1 and B_2 and run in opposite directions and at different speeds. On the other side the shafts B_1 and B_2 are interconnected by gear wheels R_5 and R_6 which are of equal diameters and held fast on their respective shafts. The arrangement is such that if either of the shafts is set into motion by the interconnected friction couplings C' or C'', both shafts must run in opposite directions and at speeds corresponding to the number of teeth in the gear wheels R_3 or R_4. Further on the shafts B_1 and B_2 are set the loose sprocket wheels D_1 and D_2 which may be connected rigidly with their respective shafts by means of appropriate claw clutches F_1 and F_2.

The driving axle is driven from the sprockets D_1 and D_2 by the chains G_1 and G_2. To change the running speed all that is necessary, therefore, is to change the engagement of the friction couplings.

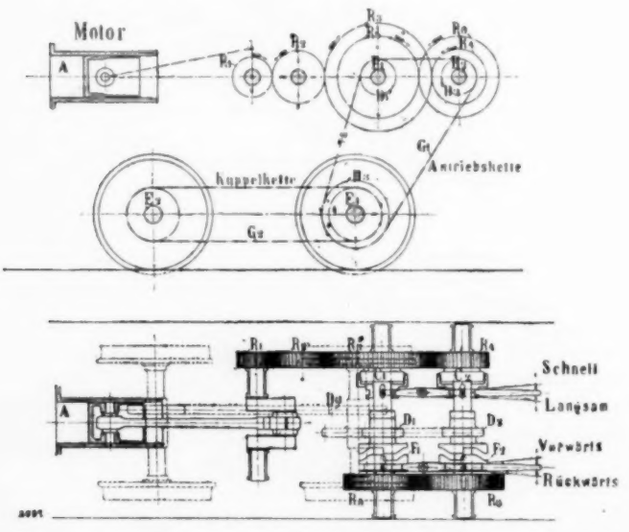


FIG. 7 CHAIN DRIVE OF THE DEUTZ INTERNAL-COMBUSTION MINE LOCOMOTIVE (2-SPEED TRANSMISSION)

(*Antriebskette* = driving chain; *kuppelkette* = transmission chain; *schnell* = high speed; *langsam* = low speed; *vorwarts* = forward; *ruckwarts* = reverse.)

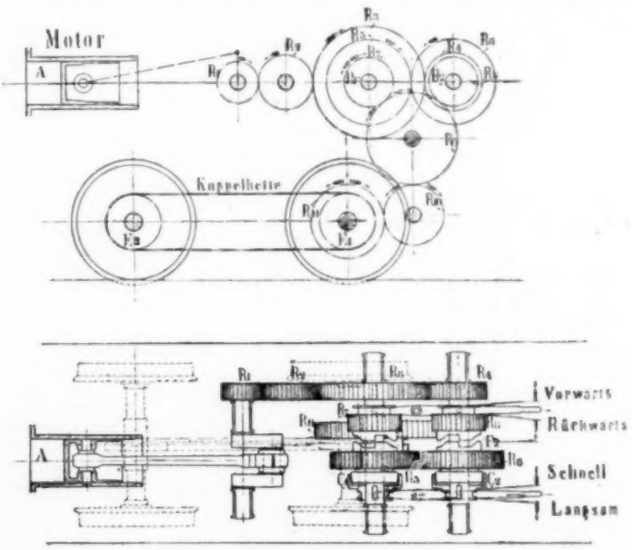


FIG. 8 GEAR DRIVE OF THE DEUTZ INTERNAL-COMBUSTION MINE LOCOMOTIVE (2-SPEED TRANSMISSION)

(*Kuppelkette* = transmission chain; *schnell* = high speed; *langsam* = low speed; *vorwarts* = forward; *ruckwarts* = reverse.)

While to change the direction of running, the clutches F_1 and F_2 may be used.

In the arrangement shown in Fig. 8 the same general construction is used as in the previous case but the drive is transmitted through the gears R_7 to R_{11} instead of through sprockets and chains.

Mine locomotives in Germany are built in sizes of from 4 to 5 hp. to as high as 60 to 70 hp. (First of a series of articles in *Oel-u. Gasmaschine*, vol. 17, no. 12, December 1920, pp. 177–180, 7 figs., *d*)

Comparison of Theories of Elongation and of Shear Stress

A Comparison of the Theories of Elongation and of Shear Stress, Prof. H. Bonte. When a machine part is stressed simultaneously in tension and torsion or bending and torsion there arise in it stresses as to the magnitude of which there is as yet no agreement.

In continental Europe these stresses are evaluated on the basis of the maximum elongations caused by them, which is in accordance with views dating back to St. Venant (theory of elongation). Since, however, the engineer has no direct way of determining the specific elongations, the actual elongation is simply multiplied by the modulus of elasticity E. In this way a value is obtained which may indicate the magnitude of the stresses present when the load on the body is applied along a single axis. The formula by which this stress is computed reads as follows:

$$k_z \geq \sigma_i = 0.35\sigma + 0.65\sqrt{\sigma^2 + 4\tau^2} \quad \ldots\ldots [1]$$

It is made to agree more closely with practical values by the application of the Bach method, in accordance with which the so-called "coefficient of effort" $\alpha_0 = k_z/1.3k_d$ is added to the shear stress τ, in which event the formula is written as follows:

$$k_z \geq \sigma_i = 0.35\sigma + 0.65\sqrt{\sigma^2 + 4(\sigma\tau_0)^2} \quad \ldots\ldots [2]$$

In this equation k_z(or k_d) is the permissible stress in tension (or torsion) for the given material under the given conditions, σ_i the ideal stress in tension as described above (elongation × modulus of elasticity), σ the maximum normal stress produced by the tension or bending, and τ the maximum shear stress produced by the torsion.

In England and America principal stresses computed in accordance with the Rankine equation $\sigma_{max} = {}^1/_2\sigma + {}^1/_2\sqrt{\sigma^2 + 4\tau^2}$ are used, but this formula is losing ground in those countries and has been entirely abandoned in continental Europe.

On the other hand, the theory of shear stress developed on the basis of experiments carried out during the last 20 years starts from the viewpoint that it is the shear stresses in a body that cause various disturbances. The maximum possible shear stress is computed by the equation

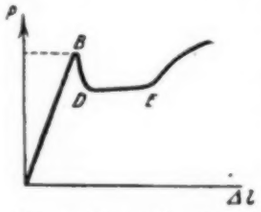


Fig. 1 Stress-Elongation Curve

$$\tau_{max} = {}^1/_2\sqrt{\sigma^2 + 4\tau^2} \quad \ldots\ldots [3]$$

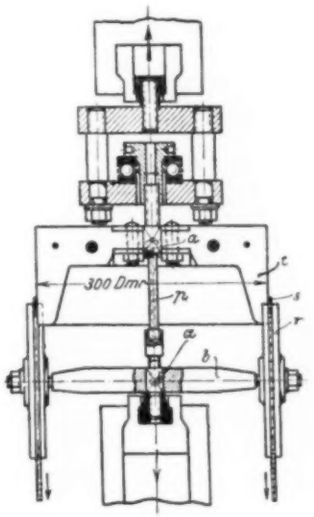
and τ_{max} with single axial loads is only half as great as the stress in tension. Numerous investigators, however, have vigorously questioned the correctness of this theory also, and in its stead several others have been proposed, of which the most important is the one suggested by Mohr in 1900.

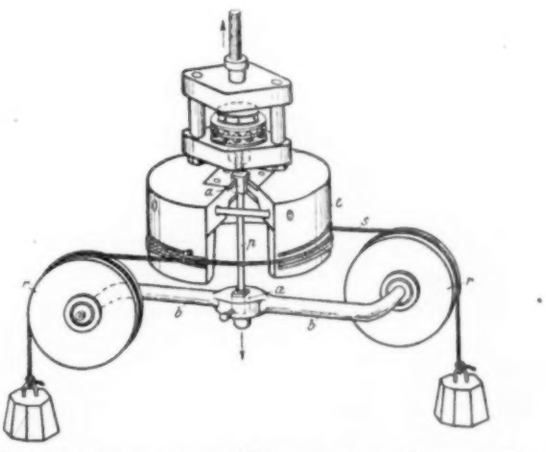
There are insuperable difficulties in the way of experimentally testing the correctness of any of the formulas proposed, as it is impossible at present to determine the stresses existing in the interior of a body. The only thing we can do is to measure the elongations and then compute the stresses that produce them on the assumption of proportionality in accordance with Hooke's law. This procedure, however, cannot be applied when we are dealing with combined stresses, because then single elongations cannot be measured any more, and, furthermore, Hooke's law does not apply for phenomena occurring beyond the elastic limit.

The following method may be applied in order to test the correctness of the various equations proposed for the determination of stresses.

The tension-elongation curve (Fig. 1) for soft iron, which is of importance in machine construction, runs as follows: After passing the limit of proportionality at the point B (upper yield point) where it reaches a maximum, it falls off down to the point D and then continues in a practically horizontal line. At E, however, the stress begins to rise again.

While, in general, the material does not indicate the stresses occurring therein, an exception to this rule occurs after the upper yield point B is passed, in that the scale beam of the testing machine suddenly drops, owing to the decreased resistance in the bar. If we start out with the assumption that a similar material independently of the method in which the stress is produced will suddenly give way at a predetermined stress, we can consider the dropping of the scale beam as an indication that through the coöperation of such tensional and torsional stresses as may be present the yield limit has been reached. If then we should compute the individual values of the tensional and torsional stresses according to the various formulas under consideration, that equation will prove to be entitled to greater consideration which under the various conditions of testing will give the same stress for the yield point at which the dropping of the beam takes





Figs. 2 and 3 Apparatus for Determining the Limit of Elongation in Test Bars

place. With this in view, the tests have been carried out on a testing machine with the auxiliary device illustrated in Figs. 2 and 3.

The test piece p is held at both ends in rectangular holders a. To the upper holder is attached a split wooden drum t, while the lower holder carries an S-shaped arm b with two rollers r (on ball bearings). The cord s transmits the torsional moment from the weights to the test piece p.

In the first instance Equations [1] and [3] of the theory of elongation and theory of shear, respectively, were tested and the data of these tests are presented in Figs. 4 to 7 where the moments of torsion are plotted as abscissae. These moments of torsion were obtained through a drum 30 cm. (1.18 in.) in diameter. The maximum torsional stress produced in the test piece and computed in accordance with the formula $\tau = 16M_d/\pi d^3$ is represented by an inclined straight line passing through the origin of coördinates. The tension stresses σ at which the scale beam drops down are plotted as ordinates. As was to be expected,

these stresses decreased with the increase in the moment of torsion.

The proper values of σ and τ were then computed and plotted first in accordance with Equation [1] (σ_i curves in Figs. 4 to 7) and then in accordance with Equation 3. The values τ_{max} were also plotted, since at $M_d = 0$, $\sigma = \sigma_i = 2\tau_{max}$.

Fig. 4 shows at a glance the superiority of Equation [1] as the values of σ_i remain approximately equal for all moments of torsion in clear distinction from the sharply rising curve of $2\tau_{max}$.

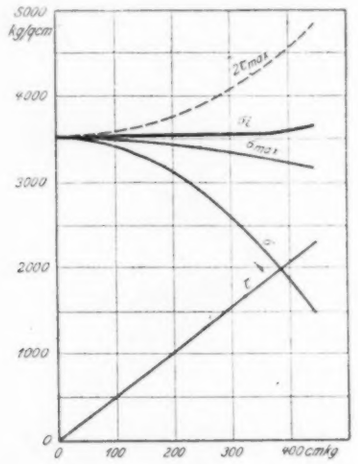


Fig. 4 Upper Yield Point in Solid Test Bars

In addition to tests for the upper yield point, tests were also carried out to the fracture point. Here the values of σ_i increase with increasing moments of torsion, though not in the same proportion as the values of $2\tau_{max}$. These tests, however, do not prove much, as the bar contracts laterally and the proportionality

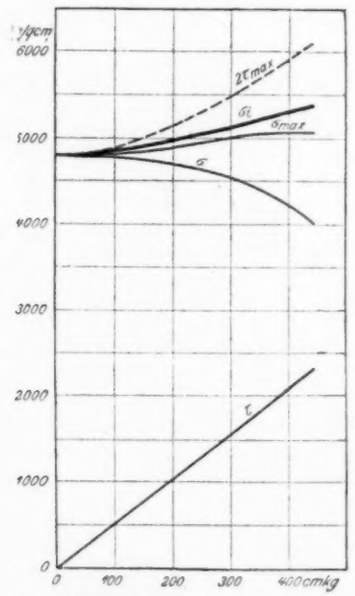


Fig. 5 Fracture Point in Solid Test Bars

between twist and torsional stress ceases to obtain. Because of this lateral contraction the diameter decreases, which affects the area carrying the stress in a square ratio, but the moment of resistance in a cubic ratio.

After the completion of the first series of tests with bars of commercial wrought iron 20 mm. in diameter and 100 mm. long, the question arose as to whether it is correct to compute the torsional stress even at the upper yield point under the assumption of the applicability of the law of proportionality, that is, whether it is correct to apply to the moment of resistance the formula $16M_d/\pi d^3$.

If it be assumed that the limit of proportionality is exceeded even before the occurrence of the dropping of the beam, it is necessary to admit that in the full cross-section of the test piece the torsional stresses do not occur in accordance with a straight-line law, increasing from the center of the piece outward, and therefore the moment of resistance cannot be computed. If, however, it be assumed that proportionality obtains down to the very instant of the dropping of the beam, the moment of resistance can be computed. In order to secure clearer information on this point, tests were carried out with hollow rods 12 mm. (0.47 in.) outside diameter and 8.17 mm. (0.32 in.) bore, the material for the test piece being taken from the same bar as the first test pieces. The tests carried out with the solid test pieces were repeated with the hollow test pieces (Figs. 6 and 7).

In this series of tests it was found that the dropping of the beam does not occur with the same clearness as in the case of solid bars, a fact which agrees with the behavior of machined material found by Bach.

In tensile tests on hollow test pieces all hesitation regarding the permissibility of making use of the moment of resistance is elimi-

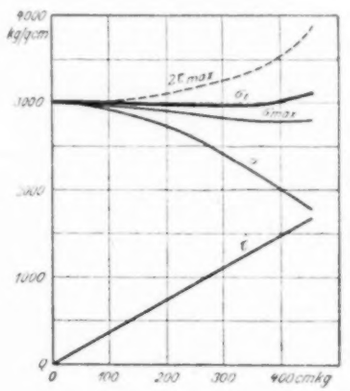


Fig. 6 Upper Yield Point in Hollow Test Bars

nated for the reason that in that case the entire material is located at approximately the same distance from the axis of torsion. This may explain why the σ_i values in the case of hollow test pieces barely vary with increasing moment of torsion, even in tests carried to the rupture point.

In this connection the author mentions the experiments of Guest, published in England in 1900, with the significant comment

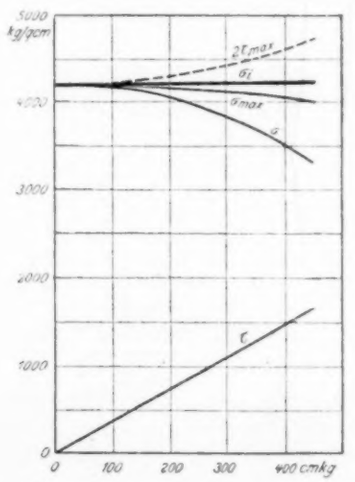


Fig. 7 Fracture Limit in Hollow Test Bars

that as Guest's values are expressed in English units, comparatively few German engineers would be inclined to devote time and attention to their study. Guest does not believe in the so-called theory of elongation. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 64, no. 51, Dec. 18, 1920, pp. 1071–1073, 7 figs., *pe*)

Short Abstracts of the Month

AERONAUTICS

AERONAUTICS IN 1920 IN GREAT BRITAIN. A general review of events of the past year, of which the part referring to commercial aeronautics is of particular interest.

From an examination of results obtained on the mail service from London to Paris, it would appear that out of 391 flights 298 (76 per cent) were completed without a delay of more than three hours. In 16 cases the flights were completed during the day on which they were started, but without a delay of more than three hours. In 77 cases the flights were either completed on the following day, not completed at all, or not started.

Railway passengers would probably have just cause to complain if one train in every four on a certain line between two cities failed to make the trip with a delay less than three hours.

It has also been found that aerial transportation both of passengers and freight is still very costly as compared with other methods. The main reason, however, why the public distrusts aerial transportation is on account of the impression of danger.

Turning to the records of the past year in England it is found that during the seventeen months from May 1919 to September 1920, according to Air Ministry statistics, 100,285 passengers were carried in England in machines licensed for civilian flying. In this period seven pilots and eight passengers were killed in air accidents, and 13 pilots and 15 passengers were injured. The casualty rates per thousand passengers carried were thus 0.07 pilot and 0.08 passenger killed, and 0.13 pilot and 0.15 passenger injured. If the same rate of accidents prevailed on British railroads 140,000 passengers would be killed each year and over 260,000 injured, while in something like three months all the engine drivers in England would have lost their lives. Admitting that such a comparison may involve gross errors, the margin against the safety of flying is still quite great.

As regards the status of production, the Sopwith Company went into liquidation, the Aircraft Manufacturing Company was absorbed by another concern, while the British Nieuport, the General Aircraft Company, the Grahame-White and the British Aerial Transport Company have practically closed the doors. The Vickers, Ltd., has been doing some work on training machines and on an order from the Chinese Government. Several companies, however, are fairly active in developing new types. (*The Engineer*, vol. 131, no. 3393, Jan. 7, 1921, pp. 5–7, 3 figs., *g*)

AIR MACHINERY (See also Machine Shop; Wind Motors)

SCHOLL AUTOMATIC HYDRAULICALLY OPERATED AIR PUMP. The purpose of the air pump described in this article is to create automatically a vacuum in centrifugal pumps, suction lines and vacuum apparatus generally, and also to create a pressure in air chambers on pumps, air lifts, etc. Fig. 1 shows the principle on which the Scholl pump is designed. Assume that the container *a*, the riser pipe *g* and the ground pipe *r* are filled with liquid and that further the float and water valves are in positions shown in the drawing, so that gas at atmospheric pressure can be drawn in by suction. Since the outlet of pipe *r* is below the level of *a*, the liquid in *b* will flow out through *r* and force the gas through *k* by suction into the container, while the level of the liquid in the float goes down and the float itself rises. Sooner or later the upward movement of the float overcomes the pressure in the water inlet valve *i*, the valve rises and takes the open position while the exhaust valve *f* closes. The liquid flowing in through *i* passes through the channel *w* into the ring-shaped space between *a* and *b*, where because of the rise of the float the lever of the liquid has gone down thus it passes into the interior of the float. Simultaneously with this, however, the gas content in *a* is compressed and when it reaches the necessary gage pressure is delivered through *l* into the pressure line connected thereto. Shortly before the float is entirely filled with liquid the weight of the float overcomes the pressure difference between *a* and the atmosphere and opens *f*, while *i* closes under the influence of the float of the liquid under pressure.

With this state of affairs, the liquid which has previously run in runs out through *f* and *g* and the gas taken in by suction is again in position to flow into *a* through *k*, which starts the new cycle of operation similar to the one described above.

With the arrangement shown in Fig. 1 the gas is delivered to the pump through a suction line attached at *k* and passed along through *l*. The pressure liquid from the air pump is discharged at *r* of which the lower end should be bent upward to prevent the entrance of air. If the pressure of the gas taken in by suction is equal to or lower than atmospheric pressure, the lower end of *r* must be located lower than the pump, its position being determined by the specific weight of the liquid and the vacuum obtained.

With a pump of ordinary design in operating single-stage a vacuum in the ratio of ten to one or 0.1 atmosphere absolute can be obtained; in compression the gage pressure of 10 atmos. can be obtained. Where pressures higher than 10 atmos. are desired, a special high-pressure model must be employed.

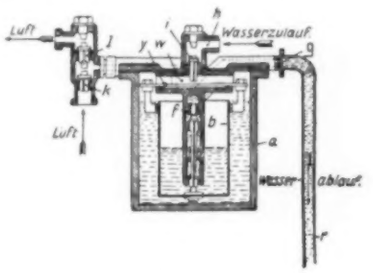


FIG. 1 SCHOLL AUTOMATIC HYDRAULICALLY OPERATED AIR PUMP
(*Luft* = air; *wasserzulauf* = water admission; *wasserablauf* = water outlet.)

Several other designs of the same pump applicable to various purposes are described and illustrated. (*Der Praktische Maschinen-Konstrukteur*, vol. 53, no. 43, Oct. 28, 1920, pp. 380–382, 6 figs., *d*)

BUREAU OF STANDARDS

GYPSUM—PROPERTIES, DEFINITIONS AND USES. Owing to the rapid growth of the gypsum industry, the nomenclature has not been standardized. A brief description of the various gypsum products will tend to fix their names.

Gypsum is a soft, white rock, usually occurring in beds. Other varieties of the same material are known as gypsite and alabaster. It is of common occurrence throughout the United States. Chemically it is a calcium sulphate combined with water. Anhydrite is a variety which contains no water.

Raw gypsum is used for the manufacture of portland cement and as a fertilizer. Calcined gypsum is made by heating raw gypsum in a kettle until the first evolution of water has ceased. It contains one-fourth as much water as the raw material. This product is frequently known as plaster of paris and is used either as such or as the basic ingredient for the manufacture of wall plaster, potter's plaster, dental plaster, etc. Large quantities of it are used in the manufacture of portland cement, plate glass, and cold-water paints.

When calcined gypsum is mixed with water it sets to form a hard mass. The time required for this reaction can be varied at will by the addition of suitable retarders or accelerators.

Neat gypsum plaster is calcined gypsum to which has been added some material (such as hydrated lime) to improve its working quality, and the proper amount of retarder. Gypsum sanded plasters are mixed with sand ready for use. Any of these plasters may or may not be "fibered" with either hair or wool fiber. And a special wood-fibered gypsum plaster is made to be used without sand.

Gypsum plasters have excellent fire-resistive ability.

The raw gypsum can be heated until all of the water is given off. The product so formed sets more quickly than calcined gypsum. It is not marketed, but is used at the factory to make such

products as gypsum tile, gypsum plaster board, gypsum wall board, etc. Further heating of the raw gypsum forms a material which sets very slowly. An accelerated variety of this is marketed as Keene's cement.

Gypsum tiles are factory-made building blocks. They come in a great variety of sizes, either plain or reinforced. They are used for building walls and roofs.

Gypsum plaster board consists usually of a sheet of set gypsum plaster between two sheets of unsized paper. It comes in many sizes, usually about 3 ft. sq. by $^3/_8$ in. thick. It is used instead of lath as a backing for plaster.

ENGINEERING MATERIALS (See Bureau of Standards)

FUELS AND FIRING

Modern Gasoline and Its Vaporization—Heated Manifolds and the "Hot Spot"

The Volatility of Internal-Combustion Engine Gasoline, Frank A. Howard. Discussion of the character of gasoline, its vaporization, and available means for improving combustion. The author sees the best solution of the present problem in a wider adoption and improvement of heated manifolds, in particular of the hot spot. Particular attention is called to data presented on the vapor pressure and inherent volatility of the gasoline of today.

Gasoline is a complex mixture of hydrocarbons, varying from pentane, the lightest, to undecane, the heaviest present. From the chemical equations of volumetric proportions of a combustible mixture it is found that a perfect combustible mixture of pentane vapor and air must consist of 40 parts by volume of air and 1 part by volume of pentane. Also a perfect combustible mixture of undecane vapor and air must consist of 1 part of the fuel to 85 parts of air, by volume. Since gasoline contains more of the lighter than of the heavier hydrocarbons, the volumetric proportion of gasoline vapor in a perfect mixture will be somewhere in the neighborhood of 1 part in 60, or 1.67 per cent.

Such a small proportion of gasoline vapor in the mixture can be brought about by evaporating the gasoline under favorable conditions and without boiling it. Dalton's laws of the vaporization of liquids state that evaporation from an exposed liquid continues until there is established a definite pressure of the vapors of the liquid, that this pressure increases with the temperature, and that when other vapors are present the total pressure of the mixture multiplied by the volumetric percentage of any constituent gives what is called the partial pressure of that constituent; so long as the partial pressure of the vapor in question is below the vapor pressure of the liquid, condensation cannot occur.

Measurements of the vapor pressure of 58 deg. Baumé gasoline in air were made with an instrument designed by C. I. Robinson, chief chemist of the Standard Oil Co. of New Jersey. First the vapor tension of the original gasoline was determined at several temperatures. Then the sample was reduced by distillation in the ordinary way, taking off successive 10 per cent fractions. After each reduction operation the vapor tension of the residual portion of the gasoline was determined at temperatures of 50, 75, 100 and 125 deg. The vapor tension in millimeters of mercury was 44.75 at 50 deg. fahr. with 90 per cent residuum, 9.66 with 60 per cent, and 4.84 with 40 per cent. At 125 deg. fahr. with 50 per cent residuum the tension was 29.50; with 30 per cent, 12.55; with 20 per cent, 8.05; and with 10 per cent, 5.07. Of the last residuum, according to the combustion equation, a perfect combustible mixture would contain 1.2 per cent. The average pressure in an engine manifold is around 0.5 atmosphere. Calling it 400 mm. of mercury, $0.012 \times 400 = 4.8$ mm. is by Dalton's law the partial pressure of the fuel vapor, assuming that the fuel is made up entirely of the least volatile fraction of the present gasoline. But, as the figures quoted indicate, at any temperature above 125 deg. fahr. the least volatile portion of the gasoline had a vapor pressure well above 4.8 mm. It follows, therefore, that even if the gasoline consisted entirely of what is at present its heaviest constituent, it would still possess sufficient inherent volatility to make it a possible fuel for an automotive engine. It is a fuel and can become and must remain a gas at an intake temperature not substantially higher than present practice. Stating it generally, complete vaporization of fuels heavier than those now sold is possible without increase of mixture temperatures; but condensation of these fuels is impossible. Manifold condensation is impossible above the temperature indicated, because it is physically impossible for any vapor to condense when its partial pressure is lower than the determined vapor pressure of the liquid itself at that temperature, and this is apparently the average condition in an engine manifold.

Utilization of the full inherent volatility of a fuel is dependent upon three factors: time, surface and heat. If heat is applied rapidly enough and at a high enough temperature, surface and time become unimportant.

Air heating and manifold heating are helpful, but apparently the means which best meets the physical requirements of volatilization is the so-called "hot spot." The definite problem is to supply heat to the fuel; not to supply heat to the air or to the mixture, but to the fuel itself. This heat should be supplied to the fuel in the presence of the air to have its maximum effect. Preheating the fuel would cause the distillation of the lighter hydrocarbons and their consequent wasteful loss. The latent heat of vaporization of the fuel must be applied to it as (or after) the mixture is made. One obvious way is to preheat the air; another, to directly heat the charge. However, the heat conductivity of air is so low that, unless this is carried to an extreme which results in substantial loss of power, there is not sufficient time for the necessary exchange of heat between the evaporating fuel drop or film and the enveloping air current.

The solution of the problem, therefore, seems to lie in the further development of the hot spot. Tests have been reported in the technical press which showed that within 35 sec. after the exhaust gases were admitted to the jacket of the hot spot the mixture passing was perfectly dry as shown by a glass manifold. The writer found in experiments with a hot spot of that design that complete vaporization of the fuel was secured with a manifold temperature beyond the hot spot of 125 deg. fahr. The surface of the hot spot itself showed a temperature of 350 deg. fahr., as accurately as could be measured. It is apparent that advanced hot-spot design has already reached a point at which automotive engineers can come very close to utilizing the full inherent volatility of the fuel by the simple and logical expedient of directly heating the unvaporized fuel in contact with the air, rather than by trying to preheat the fuel or to heat the fuel by contact with heated air. (Paper read at the Annual Meeting of the Society of Automotive Engineers, New York City, January 12 and 13, 1921, 4 pp., 1 fig., *tep*)

Importance of Hardness of Blast-Furnace Coke, Owen R. Rice. Coke to be used in blast furnaces has to be of a certain hardness because soft coke does not permit proper furnace operation. The methods thus far employed to determine the physical nature of coke have not, however, given full satisfaction.

Thus the shatter test does not fully indicate the character of coke and the author recommends instead an apparatus which has a combination of a tumbler and ball mill.

On the other hand, however, it should not be thought that the hardness of coke is the deciding element in furnace operation, though it has been found that coke of the hardness below number 81 causes trouble, while the hardness above 85 does not appear to bring any particular advantage.

There does not appear to be any clearly established rule determining the quality of coke resulting from different coals. Ash in coke has a detrimental effect on hardness. Another factor which affects the coal materially is the hydrogen-oxygen ratio. The stocking of coal affects this ratio in a very material manner. A 9-mo. stock of Davis coal showed a ratio of 102 per cent, while Davis coal direct from the mine showed a ratio of 125.8 per cent. Some 9-mo. stock of Fulton coal showed a ratio of 55.1 per cent, while Fulton coal direct from the mine showed a ratio of 57.5 per cent. (Paper presented at the Annual Meeting of the American Inst. of Mining and Metallurgical Engrs., New York, Feb. 1921, abstracted through the *Iron Age*, vol. 107, No. 6, Feb. 10, 1921, pp. 380–381, 1 fig. *ep*)

Cleaning and Boiler Economy—The Reck Heating Boiler

INFLUENCE UPON BOILER ECONOMY OF CONTINUOUS FIRING OF HIGHLY VOLATILE FUEL WITHOUT INTERVENING CLEANING, A. B. Reck. Results of two tests with bituminous coal—one made before and another after 14 days of continuous firing with the same fuel without intervening cleaning. The test results are given in the form of a table and curve, the former showing that the overall efficiency obtained in the test with clean boilers was 77.9 per cent and was lowered to 74.9 per cent, or only 3 per cent after 14 days of continuous running.

This relation between efficiency, capacity and chimney draft is shown graphically in the diagram in Fig. 2, together with similar results obtained in a great many other tests made with the same kind of fuel, viz., bituminous coal, and in the same clean boiler. The curve shows a maximum efficiency around the capacity, at which the test A was conducted. As neither the capacity nor the efficiency is seriously reduced after 14 days of continuous firing at approximately the same draft (see test B), the conclusion may be drawn that with sufficient data at hand of tests made with the same fuel and the same boiler after 14 days of continuous firing it should be possible to draw a new efficiency curve, in which the efficiency found in test B likewise will prove to be a maximum.

In order to verify the correctness of efficiency values with clean boiler and bituminous coal, tests were made in the same type of boiler with anthracite of stove size. The efficiency obtained with

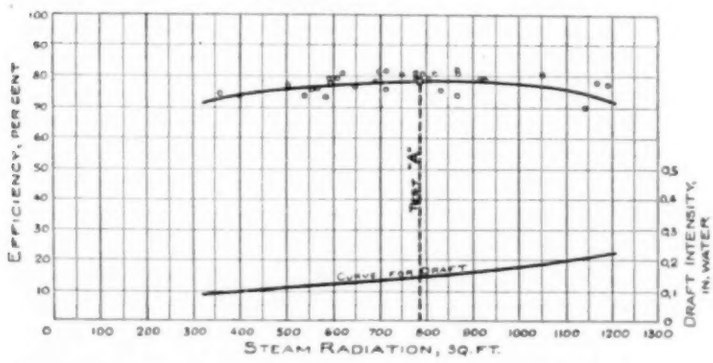


FIG. 2 EFFICIENCY CURVE FOR STEAM BOILER WITH BITUMINOUS COAL (CLEAN BOILER)

that fuel was 83.1 per cent, or 5.2 per cent higher than with bituminous coal.

The author ascribes these high efficiencies to the method employed in introducing the supplementary secondary air. Each section of the boiler is provided with an air channel located on the edge toward the combustion chamber as shown in Fig. 3. The air leaves the canals through the opposite rows of close-sitting openings in the form of jets, striking the combustible gases liberated from the surface of the fuel bed just as they are to enter the smoke flues, which are located between the boiler sections. It is claimed that this intermixing shower of fresh air evenly distributed over the whole surface of the fuel bed is sufficiently far from the surface itself to avoid acting as primary air. It is also claimed that the use of these air channels prevents the overheating of the exposed water ways, acting for them as a protection against the radiant heat. (*Journal of the American Society of Heating and Ventilating Engineers*, vol. 27, no. 1, January 1921, pp. 1–53, figs., *de*)

HEATING (See Fuels and Firing)

HYDRAULIC MACHINERY (See Air Machinery)

INTERNAL-COMBUSTION ENGINEERING (See also Fuels and Firing; and the Abstract on page 192)

AIR-TEMPERATURE REGULATION EFFECTS ON FUEL ECONOMY, Reuben E. Fielder. Test conducted by Fifth Avenue Coach Co., of New York City, to study the effect on fuel economy of regulating the temperature of the air entering into the engine cylinders. These tests were performed by means of a device operating through a Wilco spiral thermostat.

Comparative tests were made with and without this thermostatic-control device, using the same engine, carburetor and similar equipment, under the same atmospheric temperature conditions. The average saving in fuel consumption was 7.85 per cent and a 5 per cent increase in horsepower was obtained when using the thermostatic control.

The temperature in the manifold when using the thermostatic control was constant, whereas without this device it varied from 130 deg. fahr., as a minimum, to 160 deg. fahr., which showed a loss of power and increased consumption of fuel at all speeds, indicating a loss in volumetric efficiency due to excessive heat. This test was made at a time when the atmospheric temperature was 68 deg. fahr. What happens when the atmospheric temperature is around 90 deg. fahr. as in the summer, or 0 deg. fahr. as in winter, can well be imagined.

The best manifold temperature for the gasoline used was found to be 102 deg. fahr. This temperature was determined upon after tests in which the engine speed was held constant while varying the temperature in the manifold, the power developed

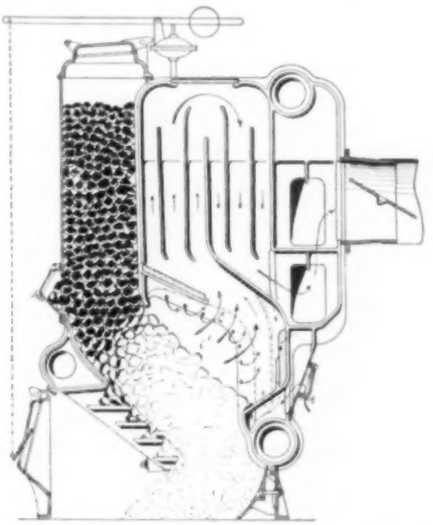


FIG. 3 VERTICAL SECTION THROUGH RECK BOILER

and the fuel consumption being recorded. The speeds selected were 700 and 1200 r.p.m., thus representing the high and low limits of speed. With the thermostat set to maintain a manifold temperature of 102 deg. fahr the saving in fuel was 8 per cent or more.

Other tests were performed to observe the effect of variation of manifold temperature on economy and torque, with different jets, and also the effect of thermostatic control on the volumetric efficiency of the engine. (Paper read at the Annual Meeting of the Society of Automotive Engineers, New York City, January 11–13, 1921, 4 pp., 7 figs., *e*)

Problems Awaiting Solution in Diesel-Engine Design

PROBLEMS AND PROBABLE FIELD OF THE OIL ENGINE, Paul Rieppel. The author starts with the discussion of the economical and political problems connected with the control of the world's supplies of oil and of the application of the oil engine—by which he means the various types of internal-combustion engines, the Diesel and its modifications being first considered. In the course of the article the author makes many interesting observations and raises several questions well worth attention.

Combustion Processes. As regards the nature of combustion processes in the Diesel engine, our knowledge has reached the point where we can clearly distinguish the processes of injection, vaporization, gas formation and combustion. The author believes, however, that a very wide field in this domain remains as yet unexplored and that more work should be done in the laboratory by the physicist, such work being preferable in many cases to extensive experimentation on actual engines.

The most rapid and complete combustion is a function of the fineness of atomization, intermixture with air, and, to an extent which has not yet been fully appreciated, of turbulence. No thorough tests have been made to determine what is the best method to obtain the most complete atomization and what fineness of atomization is needed under each set of conditions.

As to the influence of catalysis in the cylinder, whether that due to presence of water or of some other catalytically acting material, the tests of Stein contain valuable material, but the influence of very small, in fact extremely small, amounts of water on fuel combustion remains as yet to be investigated. As a matter of fact we know that under certain conditions very poor oils burn better in the presence of water, and the use of other catalytic agents, such as silicon and various metals, may bring startling developments in engine design and offer a means of increasing our ability to control combustion.

How to obtain the best possible conditions of turbulence and how to evaluate the influence of turbulence are questions which may be answered by tests on self-ignition of oils and the velocity of flame propagation therein. In a bomb, oil vapor at rest does not ignite at all at temperatures corresponding to the temperature of compression in a Diesel engine, but when a slight turbulence is produced, as, for example, by injecting a small amount of air, self-ignition takes place. Comparatively little has been done in this direction. This and other questions must be considered by everyone interested in the subject of combustion processes, and they are not mere academic problems but important stones in the foundation upon which the structure of economic design of an engine has to be raised. Had we had this information a highly economic Diesel engine could have been designed long ago and have done away with the compressor. From this the author proceeds to the discussion of various attempts to build a Diesel engine without a compressor, such as have been proposed by Vickers, Price and Steinbecker.

Economy of Operation. In the determination of the economy of operation, questions as to the use of a 4-stroke or 2-stroke cycle, high or medium pressures, are ones which lie at the foundation of the problem. After discussing briefly the relative position of the 4- and 2-stroke cycles and the question of scavenging, the author proceeds to the question of compression and asks whether we shall continue to operate Diesel engines with a compression of 35 atmos. and the heavy weight of the engine and mechanical difficulties which it involves.

The higher thermal efficiency secured with this compression does not have decisive value in the author's eyes, as motors employing lower compression pressures would have a lower first cost, be more reliable and show a better mechanical efficiency. As regards the advantage secured through self-ignition of the mixture, it is pointed out that the point of self-ignition is lowered very materially when the cooling produced by the expanding stream of the injection air is eliminated. With solid injection every condition of engine operation can be met without external means of ignition at a pressure of 25 atmos. But even assuming that self-ignition would have to be dispensed with, why not? The high value placed on the ability of the engine to operate on a basis of self-ignition is a survival of a time when electrical ignition was still complicated and unreliable. Today it is quite easy to provide reliable means of producing a good electric spark having a good control of timing, or, where necessary, to produce a wire spirally wound and maintained constantly at a glowing heat by a flow of electric current. There is no reason why one should not employ outside methods of ignition in engines in which the most economical operation may be secured at compressions at which self-ignition can no longer be relied upon.

In connection with the problem of securing the most economical operation of oil engines, the author takes up the question of utilization of waste heat. It is true that as high as 40 per cent of the heat in the fuel may be usefully employed in the oil engine, but this is no reason why one should waste the other 60 per cent without any effort at recovery. The comparison with the 12 per cent heat efficiency of the steam engine is often misleading because in a steam engine a good deal of the heat in the exhaust steam may be still utilized for purposes of heating and drying. In properly conducted factory processes employing steam, the power generated by the steam engine should be considered as a mere by-product, while in the case of oil-engine drive it is the main if not the only product of fuel combustion.

The problem of utilizing the waste heat of oil engines is one of the most important from an economical point of view. The usual way is to pass the exhaust gases on to steam boilers, a method well known in large gas-engine operation. This cannot be done as conveniently with oil engines, because the temperature of the exhaust gases is considerably lower. Furthermore, any attempt at a thorough utilization of exhaust heat from oil engines would involve a considerable increase in the first cost of the installation and also possibly corrosion troubles due to the presence of sulphurous acid in the exhaust gases. In particular, in the case of auxiliary boilers on shipboard, it has been found advisable to equip them with direct oil heating in addition to heating by exhaust gases. An important physical problem is the determination of the coefficient of heat transfer from exhaust gases to the boiler wall. This is a question proposed by Nusselt, but, in general, the coefficients now employed are more or less of a rough nature and do not take into consideration many important factors.

In this connection may be mentioned attempts to mix the exhaust gases with steam and to add to them compressed air and utilize the mixture either in turbines or in reciprocating engines. It does not appear than any such efforts may lead to useful conclusions.

In another part of the same article, which will be abstracted at an early date, the author discusses the application of oil engines, in particular those operating on heavy oils as opposed to gasoline and kerosene engines, to various specific purposes, such as the driving of locomotives, road vehicles, tractors and aircraft. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 64, nos. 49 and 50, Dec. 4 and 11, 1920, pp. 1021–1027 and 1051–1055, 10 figs., *gA*)

MACHINE SHOP

Sand Blasting, C. W. Starker. A practical article describing the types of apparatus, abrasives, nozzles, air pressures, dust exhausting and general methods of operating.

There are several systems of sand blasting differing in the manner of applying the stream of abrasive to the surface to be treated. Air compressed to varying pressures is commonly employed in all sand-blasting equipment, but the pressure is applied in different ways.

In the direct-pressure system the air and the abrasive are combined in and discharged from a closed tank through a nozzle. In the suction system the abrasive is carried to the nozzle by the suction created by a jet of compressed air, which, in passing through the nozzle, carries the abrasive with it. This system is also known as the siphon system. For this system an apparatus known as the sand-blast gun is employed. In the third system, known as the gravity system, the abrasive is carried by mechanical means to a place above the nozzle and is fed down by gravity.

In general it may be said, other things being equal, that the higher the air pressure used the stronger the force of the jet discharged against the surface to be treated, and therefore the greater the amount of work done. It may be roughly stated that according to actual practice 50 lb. air pressure will perform twice as much work as 20 lb., or 65 lb. will accomplish twice as much as 30 lb., and 72 lb. twice as much as 40 lb. The air pressures used for different materials are as follows (fair average practice): Steel castings or forgings, 80 to 100 lb.; malleable iron, 70 to 85 lb.; cast iron, 60 to 70 lb.; and brass and aluminum, 35 to 50 lb.

The volume of air flowing to a nozzle opening at a given pressure is governed by the size of the nozzle. (Table 1). As the nozzle is apt to wear, however, it is important to design it so as to reduce this wear as much as possible. Moisture in compressed air prevents an even flow of abrasive and causes the sand to form lumps. It is also detrimental to pneumatic tools which are operated from the compressed-air system.

As regards the abrasive materials, sand is the most commonly used on account of its relatively low price. Ordinary lake or river sand is inferior to sea sand and silica sand. Abrasives, such as steel grit and shot are used to a certain extent, but are not suitable

for such classes of work as electroplating or galvanizing, as the adherence of metallic dust prevents the success of the final process. All abrasives should be screened each time before using to remove particles large enough to plug the nozzle and also to eliminate fine particles which only produce dust and have no abrasive quality.

TABLE 1 FLOW OF FREE AIR FOR DIFFERENT SIZES OF NOZZLES

Diameter of nozzle, in.	Pressure (Cu. Ft. per Min.) and Corresponding Horsepower Required — 20 Lb.	Hp.	30 Lb.	Hp.	40 Lb.	Hp.	50 Lb.	Hp.
1/8	7.70	0.63	10.00	1.03	12.30	1.50	14.50	1.99
3/16	17.10	1.40	22.50	2.32	27.50	3.26	32.80	4.49
1/4	30.80	2.53	40.00	4.12	49.10	5.99	58.20	7.97
5/16	48.17	3.95	62.89	6.48	76.60	9.36	90.70	12.43
3/8	69.00	5.66	90.00	9.27	110.00	13.42	130.00	17.81
	60 Lb.	Hp.	70 Lb.	Hp.	80 Lb.	Hp.	100 Lb.	Hp.
1/8	16.80	2.57	19.00	3.19	21.20	3.86	25.73	5.33
3/16	37.50	5.74	43.00	7.22	47.50	8.65	57.88	11.98
1/4	67.00	10.25	76.00	12.77	85.00	15.47	103.00	21.32
5/16	105.00	16.07	119.00	20.00	133.00	24.10	161.00	33.82
3/8	151.00	23.10	171.00	28.73	191.00	34.76	232.00	47.90

It is important to have the sand-blast rooms well ventilated. In the majority of cases it is also necessary to provide methods for gathering and settling the dust rather than discharging it into the atmosphere. (*Machinery*, vol. 27, no. 5, Jan. 1921, pp. 458–462, 11 figs., *p*)

WORK SPEEDS IN CYLINDRICAL GRINDING, Robert J. Spence. The author claims that the importance of the function of the speed-changing device in grinding machines does not seem to be understood in general by the operators, of whom a very large number believe that the faster the work revolves the greater the amount of work produced. The author believes this is erroneous and that to operate a grinding machine continually on the fastest work speed is just as wrong and just as wasteful as it would be for a lathe operator to run his machine continuously at a filing speed when turning work.

To prove this, the author analyzes a case where a man is grinding a bar of steel and using the fastest work speed and fastest table traverse with which the machine is equipped. He shows that when an excessively high speed is used only part of the wheel face is presented to the work, and when such a thing happens the remaining part simply laps over on the surface ground during the preceding revolution of the work and there is a non-uniform wearing action. The portion of the wheel face which is not cutting but simply dragging on the work becomes glazed and adds useless friction to the operation, thus increasing the power consumption of the machine.

The importance of using the greatest possible radial depth of cut is next discussed. Even a small increase in the radial depth of cut permits for the same amount of work to reduce the number of table traverses, which, for the same rate of traverse, means a material reduction in the time consumed in grinding a piece.

The question of the effect on the amount of stock removed in its relation to wheel wear when the speed of grinding is reduced, is also discussed in some detail on the basis of the graphic analysis of the action of a grinding wheel proposed by Prof. George I. Alden. A discussion of the numerical case indicates that in that instance a change of work speed from an excessive rate of 190 r.p.m. to a more rational speed of 75 r.p.m. increases the amount of stock removed per unit of wheel wear 150 per cent. (*Machinery*, vol. 27, no. 5, Jan. 1921, pp. 438–440, *p*)

MEASURING INSTRUMENTS

USE OF THE MACMICHAEL VISCOSIMETER IN TESTING PETROLEUM PRODUCTS, W. H. Herschel and E. W. Dean. The MacMichael viscosimeter is of the torsion type. Its essential parts are a rotatable motor-driven oil cup and a torsional pendulum suspended above the center of the cup by a piano wire. The cup has an inside diameter of about 70 mm. (2–13/16 in.), is equipped with an external heating coil of resistance wire (which can be used only when the cup is at rest), and is set in an oil jacket which also revolves. The cup is driven with a set of speed-reducing gears by means of a small electric motor. The latter is equipped with a speed-control device of the phonograph type and it is possible to attain very reliable and accurate regulation of the rate of rotation of the cup.

The pendulum consists of a tube inclosing the suspension wire and carrying a disk at its lower end, an oil-filled dashpot slightly below the middle of the tube, and a graduated dial near the point of support. The disk is about 60 mm. (3–5/16 in.) in diameter and 5 mm. (3/16 in.) thick. The dashpot, attached to a support cast on the frame of the instrument, serves to minimize oscillation of the pendulum and also is a convenient device to indicate when the whole instrument is properly leveled.

The dial is fastened to the tube by a tapered fit and is graduated from 0 to 300 for reading the angular deflection of the pendulum. The zero setting is made roughly by turning the dial on the tube, and more accurately by movement of the pointer attached to the support of the pendulum.

The instrument may have wires of different sizes.

Some of the limitations of the instrument are indicated by this description. It is obvious that one of the most vital parts is the suspension wire and that this can easily be injured either through careless handling or by using a wire with so viscous an oil that the deflection is sufficient to strain the wire. One of the vital dimensions controlling the readings obtained is the clearance between the bottom of the disk and the oil cup. The method of attaching the wire in the disk is such that it is practically impossible to control this clearance, which is a disadvantage in that it renders a new calibration necessary every time a wire is removed and replaced. Changing of wires is frequently necessary, as one of the principal disadvantages of the instrument is the range of viscosity that can be covered by the use of properly selected wires of different diameters.

The advantages of the MacMichael viscosimeter as compared with the usual efflux types are (1) that the time consumed in making a determination with it is relatively small, and (2) that it gives moderately accurate results with oils that are not perfectly homogeneous. This latter is important in measuring the apparent viscosities of such substances as emulsified products or used automobile crankcase oils containing both water and finely divided sediment. Efflux type viscosimeters (such as Saybolt) are extremely unreliable for testing products of this sort, while with the MacMichael instrument reasonably accurate measurements can be made. It is also of value in distinguishing true liquids from plastic solids.

The limitation, in addition to what is stated above, lies in the fact that its construction is such that calibration of the instrument in terms of its dimensions is impracticable.

It is important to bear in mind that the readings of the MacMichael viscosimeter are related to absolute viscosity instead of kinematic viscosity, and it is therefore necessary to know the specific gravity of the oil tested before MacMichael readings can be translated into terms of Saybolt seconds. This, however, introduces no difficulty as it is the practice in the petroleum industry to measure the gravity of all samples anyway.

The paper gives careful directions for the calibration of the apparatus and for the methods of its use. Among other things, an interesting method is suggested for measuring absolute viscosities with the Saybolt viscosimeter. (Reports of Investigations of the U. S. Bureau of Mines, Serial No. 2201, Jan. 1921, abstracted from mimeographed copy, *tp*).

MECHANICS

TORSIONAL STRENGTH OF MULTIPLE-SPLINED SHAFTS, C. W. Spicer. Comparative torsional tests of splined shafts and full-round shafts.

Fifteen shafts were tested. Five were splined with small diameter of 1.315 in. and outside diameter of 1.5874 in. The other ten were full-round shafts, five 1.2806 in. in diameter and five 1.5 in. in diameter. This last diameter was computed as the theoretical equivalent of the splined shafts. The 1.2806-in. shafts were intended to have the same diameter as the small diameter of the splined shafts, but they were reduced to the size that would clean up by grinding the most badly warped shaft in the

heat-treating operation. All of the full-round shafts had at the ends practically the same diameter as the large diameter of the splined shafts.

Curves were plotted showing twist against torsional stresses. An Olsen torsion-testing machine was employed and readings were taken by means of the Olsen troptometer attachment. The average readings obtained with the five shafts of each series were used.

It was found that a twist of 0.2 in. measured on a 12-in. radius between 9-in. centers was produced in the full-round shafts with the small diameter by a load of 6000 lb. per sq. in., while 8350 lb. per sq. in. was required to produce the same twist in the splined shafts and 11,500 lb. per sq. in. in the theoretically equivalent full-round shafts. For a twist of 0.3 in. the figures were 9000, 12,250 and 17,000 lb. per sq. in., respectively, for each of the three classes of shafts. Similarly for 0.4 in. twist, 12,000, 16,500 and 22,500 lb. per sq. in.; and for 0.5 in. twist, 15,000, 20,000 and 27,800 lb. per sq. in. At this point the Johnson elastic limit was located for the splined shafts, that is, the unit increment of deflection per unit load increase was 50 per cent greater than at the beginning. The Johnson limit occurred in the small round shafts at a load of 22,000 lb. per sq. in. with a twist of 0 78 in., and at 32,000 lb. per sq. in. with 0.58 in. twist in the theoretically equivalent round shafts. (Paper read at the Annual Meeting of the Society of Automotive Engineers, New York City, January 12 and 13, 1921, 2 pp., 4 figs., *e*)

Three-Point Suspension for Automobile Engines, One Point Being Rigidly Fixed

A NEW PRINCIPLE OF ENGINE SUSPENSION, S. E. Slocum. Discussion of application of three-point system of support to automotive engines as a means for eliminating the vibration due to synchronism.

In designing a system of engine suspension which will eliminate vibrations, it is well to remember that there are two main types of vibration, one due to unbalance and the other to synchronism.

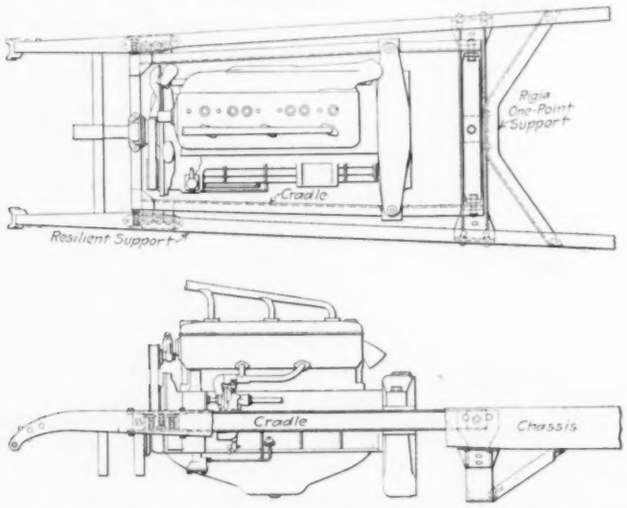


FIG. 4 APPLICATION OF THE THREE-POINT PRINCIPLE OF SUPPORT TO AUTOMOTIVE APPARATUS

The first can be eliminated by well-known methods of balancing, leaving only the vibration due to torque recoil and inertia forces. The second can be eliminated by preventing synchronism, and this can be accomplished by isolating a machine from its support so far as the transmission of vibrations is concerned. To explain what this implies, it is pointed out first that any body may have at most six degrees of freedom; that is, it may be free to move along any three mutually perpendicular axes, giving three degrees of freedom, and it may also be free to rotate about these three axes, giving the remaining three degrees of freedom. If one point of the body is fixed, this destroys the first three degrees of freedom since the body can no longer move as a whole in any direction; but it is still free to rotate about any axis through the fixed point, so that it still possesses three degrees of freedom as regards rotation.

To apply this to the automotive engine, suppose that one point of the engine is fixed, so that it can pivot about this point. Suppose that, in addition to this one fixed point, two other points of the machine are mounted on resilient supports. It is then evident not only that the machine will have three-point support, but also that within certain limits it will have freedom of motion about the fixed point, due to the resiliency of the other two supports. This type of three-point support, one point being rigidly fixed and the other two supports being elastic or resilient, leaves the body three degrees of freedom, and yet makes it possible to control absolutely the period of the vibration. In other words, by properly designing or adjusting these resilient supports it is possible to change the period of vibration so as to prevent any possibility of its synchronizing with the natural period of the engine bed or foundation.

Fig. 4 illustrates a three-point-support system as applied to automotive engines. The method consists in mounting the engine in a cradle, and supporting this cradle on the chassis at three points. The rear support is here the rigid point of the three, and in this case is placed directly underneath the transmission. The two forward supports are the resilient ones and are formed by interposing coiled springs between the cradle and the chassis. A special form of double telescoping spring is used, which permits vibrations of very small amplitude, but is very rigid as regards road shocks. In fact, the action of the resilient supports is exactly the opposite of the ordinary shock absorber. The supports absorb vibration but do not respond to road shocks.

It should be noted that this method of suspension supplements, but does not replace, careful balancing of all rotating parts; furthermore, that its use will improve the performance of any type of engine, although most needed by the four- and eight-cylinder types. (*The Journal of the Society of Automotive Engineers*, vol. 8, no. 1, Jan., 1921, pp. 54–56, 1 fig., *tp*)

MOTOR-CAR ENGINEERING (See also Mechanics)

POWER GENERATION (See also Wind Motors)

Power Generation from Natural Hot Waters

POWER GENERATION FROM NATURAL HOT WATERS, P. Caufourier. In a number of places in France, northern Africa, Syria, Martinique, New Caledonia, etc., there are natural sources of hot water, and attention has been drawn to them as a possible source of power generation through the rise of cost of fuel in the last few years.

The idea itself is not new, and several attempts have been made to employ such water for useful purposes. In 1917 Gabrié presented to the Academy of Sciences in Paris a proposal to vaporize water by means of heat in the interior of the globe, believing that the depth to which the water would have to be delivered would not be prohibitive.

In the present instance, however, the discussion is confined to the use for purposes of power generation of hot water as it comes out of the ground without adding any heat through external combustion. This is intended to be done by means of "self-evaporation" of natural hot water. The theory of this is as follows: Let there be a weight P of water at the temperature t_0 enclosed in an adiabatic chamber under an absolute pressure below the saturation pressure of steam at t_0. The liquid will then evaporate partially up to the point of saturation of the free space, and in doing so will borrow the latent heat of evaporation from the non-evaporated part of the liquid. Let t_1 be the final temperature and p the weight of the vaporized liquid. We then have the equation

$$P(t_0 - t_1) = p(606.5 - 0.695t_1)$$

A drop in temperature of 6 deg. cent. will vaporize about 1 per cent of water (by weight). If now the vaporizer be placed in communication through a turbine with a condenser of temperature t_2, saturation will no longer occur and steam generation will be continuous. The output of steam will be a constant one on condition

that the water cooled down to the temperature t_1 is continuously removed and replaced by water at a temperature of t_0. In condensing, the steam will give up a quantity of heat equal to

$$p(606.5 + 0.305\,t_1 - t_2)$$

and the work which can be theoretically usefully employed is represented by the product obtained by multiplying this quantity by the mechanical equivalent of heat (425) and by the Carnot efficiency coefficient $(t_1 - t_2)/(273 + t_1)$, all values being in c.g.s. units.

The application of this method of computation to various values of t_1 and of $t_0 - t_1$ when $t_2 = 27$ deg. cent. gives the results shown in Table 2, where for each of the three temperature differences the first line represents the water vaporized by the cooling of a cubic meter of water from t_0 to t_1, and the second line represents the corresponding output of power (theoretical) in metric horse-

TABLE 2 WATER VAPORIZED AND POWER GENERATED IN A LOW-TEMPERATURE SELF-VAPORIZING BOILER

	Values of t_1					
	45 deg.	54 deg.	63 deg.	72 deg.	81 deg.	90 deg.
$t_0 - t_1 =$ 6 deg.	10.4	10.54	10.66	10.78	10.9	11.03
	0.55	0.816	1.076	1.309	1.581	1.829
$t_0 - t_1 =$ 9 deg.	15.6	15.81	15.99	16.17	16.36	16.55
	0.825	1.224	1.614	1.964	2.372	2.744
$t_0 - t_1 =$ 12 deg.	20.8	21.08	21.34	21.56	21.81	2.744
	1.10	1.632	2.152	2.618	3.162	2.744

power-hours. For practical purposes the values in the table for the theoretical horsepower per cubic meter of water developed by self-evaporation must be multiplied by a factor representing the efficiency of the turbine and piping, which is somewhere between 0.65 and 0.75.

Applying these figures to some of the sources of hot water avail-

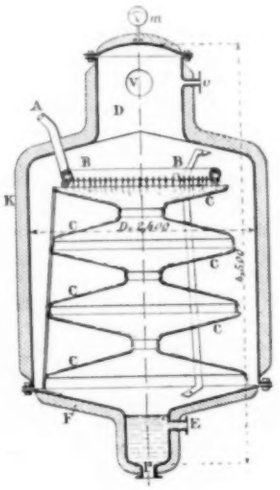


FIG. 5 CAUFOURIER SELF-VAPORIZER FOR GENERATION OF STEAM FROM WATER AT TEMPERATURES OF 50 TO 75 DEG. CENT.

able in France and Africa, the author finds that they are capable of giving outputs of from 100 hp. to as high as 12,200 hp., which, if true, would mean that natural sources of hot water represent a source of power generation which deserves serious attention under certain conditions.

So much for the theory. As far as practical realization of the problem is concerned, the first thing needed is the construction of a self-vaporizer such that heat losses shall be reduced to a minimum, and also of a turbine working at pressures below atmospheric. For this purpose, however, the present exhaust turbine may be conveniently used. As regards the boiler or self-vaporizer, a good deal has been done in the way of producing such apparatus on a small scale in various medical establishments stationed at the natural sources of hot water with a view to increasing the volume of steam for purposes of inhalation. Such is, for example, the "vaporigene" of Doctor Lajaunie, as used at Ax-les-Thermes, built somewhat like an alcohol still. In this the mixture of gas and vapor generated in the upper part is taken up by a suction pump and sent through tubes surrounded by hot water coming from the ground which vaporizes the droplets of water carried off with the steam and raises the temperature of the mixture.

For large outputs the author suggests a generator built roughly as shown in Fig. 5. The outer casing may be made either of steel or of copper according to the character of the salts and gases present in the water. In fact, as the pressure is low and the temperature not in excess of 212 deg. fahr., in some cases the casing might be made of concrete provided the water is of such a character that it does not affect the latter materially. This casing is vertical, cylindrical, and surmounted by a dome D, wherein are located the steam outlet V and the vacuum-pump outlet v. The entire structure should be protected by a good heat insulator K. The water admitted through A flows over a perforated sheet B on to a series of dished annular plates C, alternately inclined first toward the center and then toward the periphery, and provided with flanges partly to make the structure more rigid and partly to guide the flow of water. The entire assembly of plates C is rigidly attached to the bottom F, which is made demountable for purposes of periodic cleaning of the surfaces and its bottom. The solid deposits are cleaned by removing the plates C, while the mud is accumulated in the lower part of the apparatus and may be blown

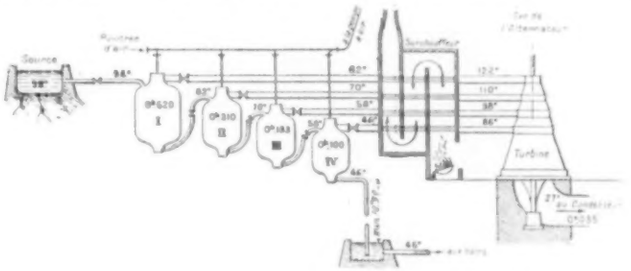


FIG. 6 PROPOSED SCHEME OF INSTALLATION FOR POWER GENERATION FROM NATURAL SOURCES OF HOT WATER

out at P. The cold water is removed through E and may either let out entirely or passed on to the next boiler having a lower pressure of evaporation.

To start the boiler the desired vacuum is created by means of a pump attached to the vacuum outlet v and then hot water is admitted, slowly at first to heat the boiler, and then at the normal rate. Steam if formed on the sheets of water flowing over the plates C and is given off either at the center or along the periphery. In order to make the flow of steam easier the plates C are smaller at the top and larger at the bottom of the generator.

From the generator (Fig. 6) the steam flows to a superheater (surchauffeur) the purpose of which is to dry the steam and raise its temperature from 35 to 40 deg. cent. (95 to 104 deg. fahr.). From the superheater the steam may go either to a series of turbines, or preferably to one low-pressure turbine. The condensers and pumps used would be of the standard types.

It does not appear from data presented in the article that any such machine has ever been built, but the subject is of considerable interest. (*Le Génie Civil*, vol. 78, no. 2, Jan. 8, 1921, pp. 37–39, 2 figs., *d*)

SHIPBUILDING

NEW DESIGN OF 10,000-TON TANKER. Description of a tanker built by Sir W. G. Armstrong, Whitworth & Co., at Newcastle-on-Tyne, England.

The most interesting feature of this vessel is the structural framing which is carried out on the Foster-King transverse system, in which the total weight does not exceed that of the longitudinally framed vessel such as is embodied in the Isherwood system.

In the King system a number of deep longitudinal girders are fitted to the bottom and sides of the vessel and also to the center bulkhead. At the transverse bulkheads these girders are carried athwartships, while one or more deep floors are arranged in each oil compartment according to its length. The deep girders on the transverse and fore and aft bulkheads are so arranged that alternate tanks are left clear for calking. (*Marine Engineering*, vol. 26, no. 1, Jan. 1921, pp. 12–15 and 2 plates, *d*)

STEAM ENGINEERING

Vertical Boiler with Water Purifier

Water Purifier in Vertical Boiler. In locomotive cranes the item of washing and maintenance work on the boiler is of great importance, especially on contract work where such water has to be used as is available.

A locomotive-crane boiler has been placed on the market equipped with an annular scale chamber located between the tubes and the shell plate as shown in Fig. 7.

The feedwater is passed through this scale chamber at about 1/200 of the speed through the intake pipe and attains a temperature at which the scale-forming impurities are liberated from solution without the use of any chemicals. The impurities are then carried in suspension, and as the movement of the water is

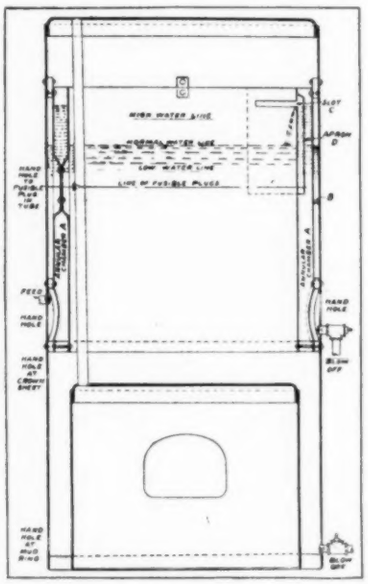


Fig. 7 Parker Locomotive-Crane Vertical Boiler with Water Purifier

very slow these suspended precipitates settle down readily to the bottom of the chamber. This settling is accelerated by the decrease in density of the water as it is heated and by the decrease in its fluid friction.

The purifier consists of the annular scale chamber *A* extending completely around the tubes with a 1-in. water space *B* between this chamber and the boiler shell. The outlet into the main portion of the boiler is the slot *C* guarded by the apron *D*. The feedwater is admitted directly to the scale chamber *A* at a point farthest from the outlet slot. It travels slowly around this chamber to the outlet and reaches, approximately, the boiler temperature before overflowing. The apron shown at *D* keeps any floating impurities, such as grease, oil, etc., from being discharged into the main boiler.

As regards the efficiency of this purifying device, it is stated that in one test of a 42-in. diameter boiler of this type at Paterson, N. J., a feedwater naturally carrying 5 grains per gal. was loaded with 70 grains of calcium and 70 grains of earth, a total of 145 grains per gal. The feed was taken from a barrel agitated with carbonic acid gas to form calcium carbonate. After about 1200 gal. of this kind of water has been passed through the boiler it was allowed to cool, when the heating surface and lower mud ring were found to be perfectly clean and the mud about 6 in. deep in the scale chamber. The blow-offs were both plugged so that all impurities remained in the boiler.

No data as to the relative sizes of the parts or as to cost of construction of the boiler are given by the author in the original article. It is stated that this boiler was designed in 1919 by Thomas T. Parker, formerly chief boiler inspector of the Fidelity and Casuality Company. (*The Iron Trade Review*, vol. 68, no. 4, Jan. 27, 1921, p. 293, 1 fig., *d*)

TESTING (See Abstract on page 193)

WELDING

Properties of Metal in Arc-Fusion Welds

Properties of Arc-Fused Metal, Henry S. Rawdon, Edward C. Groesbeck and Louis Jordan. An extensive paper, of which only the summary can be presented here. A fusion weld is fundamentally different from all other types in that the metal of the weld is essentially a casting. The arc-fusion weld has characteristics quite different from other fusion welds. A preliminary study of a considerable number of specimens welded under different conditions confirmed this general opinion concerning arc welds. A knowledge of the properties of the arc-fused metal is fundamental in any study of electric-arc welding.

Blocks of arc-fused metal of size large enough to permit a tension specimen (0.505 in. diameter, 2 in. gage length) to be taken from each were made under different conditions of fusion. Two types of electrodes, a "pure" iron and a mild steel, were used in the bare condition and also after receiving a slight coating. With these were included a set of similar specimens prepared outside of the Bureau of Standards by expert welding operators.

During the fusion the composition of the metal of both types of electrodes is changed considerably by the burning-out of the carbon and other elements, and the two become very much alike in composition. A very considerable increase in the nitrogen content occurs at the same time.

The mechanical properties of the arc-fused metal as measured by the tension test are essentially those of an inferior casting. The most striking feature is the low ductility of the metal.

All of the specimens showed evidence of unsoundness in their structure, tiny inclosed cavities, oxide inclusions, lack of intimate union, etc. These features of unsoundness are, seemingly, a necessary consequence of the method of fusion as now practiced. They determine almost entirely the mechanical properties of the arc-fused metal. The observed elongation of the specimen under tension is due to the combined action of the numerous unsound spots rather than to the ductility of the metal. That the metal is inherently ductile, however, is shown by the changes in the microstructure produced by cold bending. By taking extreme precautions during the fusion, a great deal of the unsoundness may be avoided and the mechanical properties of the metal may be considerably improved. However, the specimens as described are more representative of actual present practice in welding.

A very characteristic feature of the microstructure of the arc-fused metal is the presence of numerous plates within the ferrite crystals, arranged usually along crystallographic planes. These persist in the metal after prolonged heating; for example, 10 hr. at 1000 deg. cent. in vacuo does not remove them. The various lines of evidence available indicate that they are related to the nitrogen content of the metal, which is increased during the fusion.

Upon heating the metal above the temperature of the Ac_3 transformation, the nitride enters into solid solution in the ferrite and is retained so by quenching. Upon heating this quenched metal the plates reappear and begin to show at a temperature of approximately 700 deg. cent. The effect of nitrogen upon the Ar_3 transformation is very similar to that of an equal amount of carbon. However, there is no evidence of a transformation corresponding to the A_1 or the pearlite change due to the nitrogen in the steel.

Microscopic examination indicates that there is but little, if any, relation between these nitride plates and the path or rupture produced by tension. The effect of grosser imperfections of the metal is so much greater than any possible effect of the nitride plates in determining the mechanical properties that the conclusion appears to be warranted that this feature of the structure is a matter of relatively minor importance in ordinary arc welds.

Judged from the results obtained, neither type of electrode appears to have a marked advantage over the other. The use of a slight protective coating on the electrodes does not appear to affect materially in any way the mechanical properties of the arc-fused metal.

An extensive bibliography of physical characteristics of the metal of the weld and on nitrogen in iron and steel is appended. (*U. S. Bureau of Standards Bulletin No. 179*, 1920, 63 pp., 28 figs., *gA*)

WIND MOTORS

Efficiency of Wind Motors

THE MAXIMUM THEORETICALLY POSSIBLE UTILIZATION OF WIND IN WIND MOTORS, Dr. A. Betz. The rising costs of fuel have once more directed the attention of engineers, especially in Germany and the Scandinavian countries, to the use of wind as a source of power generation, and when engineers and not millwrights have tried to design wind-motor wheels, it has been discovered that there is an almost complete lack of knowledge as to the basic elements of the theory underlying the operation of this type of motor. The present article deals with the subject of efficiency of wind motors.

The question of efficiency in the case of wind motors is more complicated than with other prime movers, because it is difficult to determine what should be considered as the amount of power supplied to the motor by the wind. The author of the present article thinks that the power supplied to the motor by the wind should be so determined as to make it proportional to the size of the motor, in particular to the area of the wind wheel.

For example, the windmill can be considered as an inversion of an air propeller, which can be done by imagining that the wheel is moving forward in still air in an axial direction with the velocity of wind v, which substantially is equivalent to having the air move with that velocity against the wheel. If the operation of the windmill be conceived in this manner, it becomes obvious that the energy supplied to the wheel is the energy necessary in order to produce the axial translation of the wheel. If the wind exerts on the wheel a pressure in the axial direction P, then the input of energy per second is equal to P_v, and if the useful work delivered by the wheel at the shaft is L, the efficiency is

$$\eta = \frac{L}{P \times v} \quad [1]$$

This definition of efficiency satisfies the theoretical requirements as it makes it possible to see clearly what the energy supplied to the wheel is and what it amounts to. For practical purposes, however, Equation [1] is unsuitable, as the axial pressure P is a magnitude of only secondary importance for commercial purposes as bearing on the properties of a wind motor. Furthermore the work Pv is not produced at any cost to the owner of the mill.

Of greater importance in practice is the question of how much energy can be produced by a wheel of a given diameter with a given wind velocity. In order to compute the performance of a windmill in this respect, its useful output can be compared only with the kinetic energy which flows per second through a plane equal in magnitude to that of the windmill and assumed to be placed normally to the direction of the wind. If the diameter of the wheel be D, this area is $F = \pi D^2/4$; and if the wind velocity be v, then the energy flowing through that plane per second is

$$E = \frac{\rho}{2} F v^3 \quad [2]$$

where ρ denotes density of the air.

The ratio of the useful output of the windmill at the shaft to the output expressed by Equation [2], or

$$\eta_f = \frac{2L}{Fv^3} \quad [3]$$

may be called the area efficiency.

From this the author proceeds to the determination of the conditions under which for a given wheel area F the largest amount of the energy E in the wind may be converted into useful output, and what is, under these conditions, the area efficiency of the wheel. To do this the problem is conceived in an ideal manner, namely, the windmill wheel is replaced by a surface which opposes a certain resistance to the wind and thereby reduces its velocity and kinetic energy, transforming this kinetic energy into useful work with no losses. Actual windmill wheels differ from this idealized conception mainly by the fact that in their case losses occur in the process of conversion of energy which still further reduce the area efficiency. By employing the idealized conception of the wheel the numerical values of efficiencies are made larger than they can be actually, and represent really the upper limits of efficiency which are never exceeded in actual practice.

The question may arise as to why in this idealized conception the area efficiency of the plane is not unity, or, in other words, why the entire kinetic energy flowing per second through a plane of area F is not converted into useful work by the wheel which also has an area F. The reason is that because of the falling off of the kinetic energy of the air in the windmill wheel, the velocity at which the air flows through the wheel falls off also. The more the energy contained in, say, 1 cu. meter of air is utilized in the windmill, the less the velocity of the air and the less the air that flows through the wheel. There is therefore a certain optimum value of the decrease of velocity of the air at which the product of the volume of air flowing through the wheel per second by the amount of energy abstracted by the wheel per unit of air, is a maximum.

In order to carry out the computations numerically it is necessary to consider with what velocity w the air flows through the surface of the wheel. The velocity of the wind ahead of the wheel is v. Because of the loss of energy at the wheel, its velocity at the rear is v_1. If we denote the mass of air flowing through a section of the wheel surface ΔF as m, then this mass exerts on the wheel a force in the axial direction equal to

$$\Delta P = m(v - v_1) \quad [4]$$

If now the velocity at which the air flows through the wheel is w, the wind does per second the work

$$\Delta L = \Delta P \times w = m(v - v_1)w \quad [5]$$

This work results in a decrease of the kinetic energy in the wind from $^1/_2\, mv^2$ to $^1/_2\, mv_1^2$. If now the work done by the wind is equated with the kinetic energy it contains, then

$$m(v - v_1)w = {}^1/_2 m(v^2 - v_1^2) \quad [6]$$

whence

$$w = {}^1/_2(v + v_1) \quad [7]$$

The velocity with which the air flows through the wheel is therefore the arithmetic mean between the velocities ahead and behind the wheel. Knowing this velocity, we can also easily determine the amount of air which flows through the section ΔF of the wheel per second. Its mass is

$$m = \rho \times \Delta F \times w = \rho \times \Delta F \times \frac{v + v_1}{2} \quad [8]$$

where ρ is the density of the air. If we now substitute this value for m in either Equation [5] or [6], we obtain the value of the work done within the area ΔF, namely,

$$\Delta L = \rho \times \Delta F \times \frac{v^2 - v_1^2}{2} \times \frac{v + v_1}{2} \quad [9]$$

It becomes important at this point to know what must be the value of v_1 or the velocity of the air leaving the wheel, in order that with a given wind velocity v the maximum of work be done at the wheel. The author shows that this happens when v_1 is equal to $v/3$; and furthermore that the wheel of a windmill produces the maximum of its work when

$$L_{max} = \frac{8}{27} \rho F v^3 \quad [14]$$

This is, of course, only the theoretical maximum of output. If the value for L be now inserted in Equation [3], we obtain

$$\eta F_{max} = \frac{2L_{max}}{\rho F v^3} = \frac{16}{27} \quad [15]$$

as an upper theoretical limit of efficiency of the wheel. The actual efficiency however, will be lower, because of the presence of losses in the wheel. (*Zeitschrift für das gesamte Turbinenwesen*, vol. 17, no. 26, Sept. 20, 1920, pp. 307–309, *t*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquires for further information in connection with articles reported in the Survey.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves, where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Automotive Vehicles and Equipment A1–21. Starting and Lighting Batteries. The Bureau of Standards has made a brief study of starting and lighting batteries at the request of the Motor Transport Corps of the Army. The curves show the instantaneous demands upon batteries when cranking engines. The initial values of current and voltage have been obtained by the use of the oscillograph and the way in which the rapid decrease of current occurs as well as the pulsations resulting from the compression in the different cylinders is clearly shown. An interpretation of the curves shows that much additional information could be obtained with respect to the operation of the starter system and of the engine itself. The results are qualitative rather than quantitative, but indicate a possibility of using this method for the study of lubrication, ignition, compression and distributor action. In addition, an exact method is secured for measuring the speed from one revolution to another. Measurements were made at different speeds, different throttle openings and different temperatures. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Automotive Vehicles and Equipment A2–21. Carbonization of Lubricating Oils. Circular 99 of the Bureau of Standards on Carbonization of Lubricating Oils may be obtained from the Superintendent of Documents, Government Printing Office, at 10 cents per copy. The paper contains 44 pages, discusses the nature and effect of the deposits formed in internal-combustion engines, and shows that the term "carbon" is a misnomer because the deposit consists mainly of asphaltic matter. Brief accounts are given of the nature of petroleum oils and theories concerning the formation of deposits. The oxidation and cracking of petroleum are discussed in detail. Carbonization tests which depend upon oxidation and upon cracking are discussed with full description of the apparatus, and procedures for the "Waters" and "Conradson carbon residue" tests are given. The distillation methods are touched upon and the general discussion gives brief summaries of certain controversial papers, and finally it is pointed out that much is to be learned on the subject of lubrication of internal-combustion engines. This paper was prepared by C. E. Waters, Chemist, Bureau of Standards. Address Director S. W. Stratton, Bureau of Standards, Washington, D. C.

Cement and Other Building Materials A4–21. Definitions and Specifications of Lime. Circular 106 of the Bureau of Standards contains a discussion of lime, its manufacture and use. It can be obtained at 5 cents per copy from the Superintendent of Documents, Government Printing Office, Washington, D. C.

Fuels, Gas, Tar and Coke A1–21. Gas Burners. The Bureau of Standards has been investigating burner design and operation for the Industrial Fuel Committee of the American Gas Association. The result of the first part of the work is covered in a paper entitled The Design of Atmospheric Gas Burners, which will be published shortly. The work refers to industrial burners, but a study has been made of domestic burners for natural gas. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Fuels, Gas, Tar and Coke A2–21. Standards for Gas Service. Circular 32 of the Bureau of Standards deals with standards for gas service. A fourth edition of this will be released shortly and will include all changes in the standards for gas service to the end of 1920, including a short discussion of the causes which have compelled changes in the standards and the significance of such changes. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Fuels, Gas, Tar and Coke A3–21. Structure in Bituminous Coal. Report Serial 2196 on the Structure of Bituminous Coals, by Rheinhardt Thiessen, Research Chemist of the Bureau of Mines, gives a résumé of the work reported in Bulletin 117 on the Structure of Paleozoic Bituminous Coals recently issued by the Bureau of Mines. The Bulletin contains 296 pages with 160 illustrations and may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 80 cents. The report indicates the method of microscopic examination which shows that the coal is made up of parts which were at one time pieces of wood and other parts which contain humic matter, resin, carbonized material and some mineral matter. U. S. Bureau of Mines, Washington, D. C. Address F. B. Foster, Director.

Fuels, Gas, Tar and Coke A4–21. Carbonization of Lubricating Oils. See *Automotive Vehicles and Equipment A2–21.*

Leather and Glue A1–21. Leather from Rabbit Skins. Leather made from Australian rabbit skins has been tested at the Bureau of Standards. The tensile strength is low, varying from 800 to 1200 lb. per sq. in., as compared with 4000 lb. for calfskin leather. The leather exhibited little resistance to tearing. Some raw pelts were tanned in the laboratory by the one-bath chrome process, the resultant leather being the same as the original samples. Samples have many surface defects. Could be used for linings, novelties or other similar work. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Leather and Glue A1–21. Glue Data. Table 1 gives data regarding certain glues. Forests Products Laboratory, Madison, Wis. Address Director.

TABLE 1 COMPARISON OF FIVE DIFFERENT TYPES OF GLUE

(Prepared by Forest Products Laboratory)

Particular Compared	Animal Glue	Casein Glue	Vegetable Glue	Blood Glue	Liquid Glue
Source	Hides, bones, horns, etc.	Casein from milk	Cassava starch	Dried blood	Animal glue or fish parts
Cost per lb. 1920	25–42 cents	16–20 cents	10–12 cents	20 cents	$1–$5 per gal.
Spread in sq. ft. per lb.	25–35	35–55	35–50	30–100	No data
How mixed	Soaked in water and melted	Mixed cold with rapid stirring	Mixed with alkali and cold or hot water	Mixed cold	No preparation
How applied	Warm with brush or mechanical spreader	Cold with brush or mechanical spreader	Cold with mechanical spreader, not by hand	Cold with brush or mechanical spreader	Cold or warm usually applied by hand
Temperature of press	Cold, or with hot cauls	Cold	Cold	Hot	Cold
Strength (in shear (test)	High grades stronger than strongest woods	Equal to medium-grade animal glue	Equal to medium-grade animal glue	High strength in plywood. Not used for joint work	Best grades equal to medium-grade animal glue
Water resistance	Low	High	Low	High	Low
Chief uses in woodworking	For strong joint work	For water-resistant plywood or joint work	For veneer work because of cheapness	For water-resistant veneers	For repair work and small articles

Metallurgy and Metallography A7–21. Hardness of Steels by Abrasion. The relative hardness of various types of steels produced by subjecting all of them to the same abrading influence has been determined with the following results: In all cases except the high-carbon austenitic steel no pronounced effects of the abrasion were observed. The hardness of carbon steel is increased and that containing 0.85 per cent carbon shows the greatest increase. Alloy steels generally show a smaller increase in hardness of the abraded surface and in some cases show a decrease of hardness. High-carbon austenitic steels show a marked decrease of Brinell and scleroscope hardness. This process of abrasion viewed in the light of Beilby's theory may be considered as resulting in the production of amorphous matter at the expense of crystalline matter which affects the hardness of the abraded surface of the metal but probably not the general character of its structure. The decrease of hardness in the high-carbon austenitic steel may be caused by the martensite being present in a greater amount in the lower layer of the examined specimen than in the inner portion according to Benedick's pressure theory, and it seems possible that if the surface layer is ground away the next or more austenitic layer should be found somewhat softer. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography A8–21. Temper Brittleness of Steels. An extensive view of the literature on this subject has been made with the result that the nature and occurrence of temper brittleness may be summarized as follows: Certain steels which have been hardened by quenching from temperatures above the A_3 point and tempered at temperatures ranging from about 450 to 600 deg. cent. show less impact values if they are cooled slowly from tempering temperature as compared with those cooled quickly. The cause of this phenomenon, which is also referred to as "Krupp Krankheit" has not been clearly established. The property of temper brittleness has been found present in carbon steel (0.25 to 0.4 per cent), nickel, chrome-nickel, chromium and certain other alloy steels. Chrome-nickel steels of the same chemical composition and heat treatment have been found to-

vary widely in their susceptibility to temper brittleness and even in the opposite direction, i.e., the slowly cooled specimens were tougher than the quickly cooled ones. The process of manufacture appears to have more of an influence than small changes in chemical composition; thus, steels made by the acid open-hearth process are more prone to temper brittleness than electric or crucible steels. The opinion has been advanced that the degree of work and the temperature employed during the process of fabrication from the ingot bear some relation to the degree of susceptibility to temper brittleness. Other factors appearing to have an influence on the subject are the temperature of hardening preceding tempering treatment; degree of hardening, as cooling in water, oil or air; the rate of cooling from tempering temperature; phosphorus content; and the furnace atmosphere in which the material is treated. Other questions bearing upon the problem and upon some of which no general agreement has been reached and concerning which but little knowledge appears to be available are: relations between microstructure and susceptibility to temperature brittleness; path of rupture; heating and cooling curves; relation between impact values and tensile-test values as well as the Brinell hardness values; and the influence of the shape of the notched specimen upon impact-test values. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Mining, General A2–21. COAL-MINE FATALITIES IN 1920. During 1920 there was a marked decrease in the number of fatal accidents. In the first eleven months of the year 1983 men lost their lives. This was 163 less than the corresponding period of the previous year. This decrease amounts to 7.6 per cent and during this period the output was 16 per cent greater than in 1919. The production from January to November was 585,000,000 tons. The number of lives lost per million was 3.39 in 1920 as compared with 4.28 in 1919. This is covered in Report 2197 by W. W. Adams. Bureau of Mines, Washington, D. C. Address F. Bain Foster, Director.

Mining, General A3–21. MINERS' FLAME SAFETY LAMPS IN GASEOUS COAL-DUST-LADEN ATMOSPHERES. Report 2199 by L. C. Ilsley and A. B. Hooker gives the results of tests carries out in a special gallery constructed by the Bureau of Mines. Coal dust which passed through a 200-mesh screen was fed into a compressed-air line. The air line was also charged with natural gas. The tests were made by subjecting the lamps to conditions known to be on the border of failure without coal dust and then coal dust was added. No tests were made with velocities exceeding 2500 ft. per min.

As soon as the coal dust was added a change could be noted. Thirteen failures occurred out of fifty tests with unbonneted lamps and two of the thirteen failures were caused by the addition of coal dust. No failure occurred from 38 tests with bonneted lamps. The conclusions of the tests are that unbonneted lamps are less safe in atmospheres containing coal dust, provided the lamp is suddenly brought into such atmosphere when its gauze is at a bright-red temperature. Bonneted lamps are affected less by the addition of coal dust. In extremely dusty atmospheres there might be a greater tendency for the glasses to crack. Bureau of Mines, Washington, D. C. Address S. B. Foster, Director.

Paints, Varnishes and Resins A1–21. The following specifications have been prepared by the Bureau of Standards:

Circular 102:—Recommended Specification for Composite Thinner for Thinning Semi-Paste Paints when the Use of Straight Linseed Oil is Not Justified.

Circular 103:—Recommended Specification for Spar Varnish.

Circular 104:—Recommended Specifications for Asphalt Varnish.

Circular 105:—Recommended Specifications for Liquid Paint Drier.

These may be obtained from the Superintendent of Documents, Washington, D. C.

Refrigeration A1–21. NON-CONDENSIBLE GASES. Technologic Paper 180 on the Cause and Prevention of Formation of Non-Condensible Gases in Ammonia Absorption Refrigerating Machines, by E. C. McKelvey and Aaron Isaacs, was issued in October, 1920. It may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents a copy. The paper covers ten pages and discusses the effects of non-condensible gases in ammonia machines and then describes experiments with distilled water and aqua ammonia. It also discusses the method of determining carbon dioxide in small amounts and the methods for preventing gas formation. A summary of the paper follows:

1 The non-condensible gases found in ammonia absorption refrigeration machines are due to either or both of two causes, namely, (*a*) leaks of air into the system and (*b*) the corrosive action of the ammonia liquor on the metal of the plant.

2 When the foul gas is mainly nitrogen, the gas is derived from air that has leaked into the system, and leaks should therefore be sought. The oxygen in the air is very quickly used up and so will be present in only a very small percentage of its original amount. If the foul gas is hydrogen, the cause is corrosion of the ammoniacal liquor. A gas containing both nitrogen and hydrogen shows both causes to be present.

3 If a solution of sodium or potassium dichromate is added to the generator charge so that the charge in the generator will contain the salt to the extent of 0.2 per cent by weight, all foul-gas formation from the corrosive action of the ammonia charge will be stopped. It is recommended that the dichromate be added in all cases, as it has been found that its presence decreases the very small amount of gas caused by even the highest-grade ammonias.

4 A method is given for the quantitative estimation of carbon dioxide in ammonia.

Address Director S. W. Stratton, Bureau of Standards, Washington, D. C.

Ventilation A1–21. AUTOMATIC CONTROL OF HUMIDITY IN SHOPS. Technical Notes 121, Forest Products Laboratory, discusses the automatic control of humidity in shops. The apparatus developed at the Forest Products Laboratory has kept the woodworking rooms of the laboratory at a uniform temperature and humidity during the whole year. The instrument requires little personal attention. The principle upon which it acts is that of bringing the air to the dewpoint temperature for the desired atmospheric condition, saturating it with moisture at that point and then heating it without the addition of moisture to the required room temperaure. Thus if too wet or too dry originally it is brought to the proper condition. The apparatus consists of a small cabinet or chamber through which the air is drawn as often as it needs to be conditioned. The conditioning chamber contains water sprays, the temperature of which is kept constant by a mixing valve. The air then leaves the chambers and is heated to room temperature by coils. Drawings and further details may be obtained on application. Forest Products Laboratory, Madison, Wis. Address Director.

Wood Products A1–21. DRY-KILN CONSTRUCTION. Any building materials may be used. The choice depends on relative importance of first cost, maintenance and fire hazard. A well-built wood kiln is very satisfactory. The chief objection aside from fire risk is the tendency to swell and shrink, causing working of the frame and loosening of the nails. All lumber should be thoroughly seasoned. Fir, Douglas fir, yellow pine, redwood, cypress and similar woods with low shrinkage rates should be used for sheathing and sills. Good straight-grain material for frames. Sheathing should be in ship-lap form, laid horizontally and nailed twice to each stud at the middle and bottom of the board. Outside walls should be sheathed on both sides or sheathed inside and plastered outside. They should be insulated with a good moisture-proof, heat-resistant insulator. Quilt insulation between waterproof paper has not proven satisfactory. Walls should be painted with asphaltic paint. Where lumber is plentiful, crib or laminated structure may be used, employing 2-in. by 6-in. planks laid flat. Roof of similar material on edge.

Brick of hollow style is more satisfactory than wood where permanency is desired. Walls should be laid in tempered cement mortar. Unequal expansion caused by the difference in temperature of the outer and inner faces may cause cracks, which should be painted with elastic cement rather than mortar. The tile should be chosen so that openings run horizontally rather than vertically. Walls of monolithic concrete or concrete block are highly absorbent of moisture. Forest Products Laboratory, Madison, Wis. Address Director.

B—RESEARCH IN PROGRESS

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Machine Tools B1–21. See *Metallurgy and Metallography B5–21.*

Metallurgy and Metallography B5–21. MAGNETIC TESTING OF TWIST DRILLS. The Bureau of Standards is taking part in a coöperative investigation by a Committee of the A.S.T.M. on testing drills by magnetic analysis. Steel has been especially prepared for the investigation and it has been tested for homogeneity by a magnetic method at the Bureau. Drills are to be manufactured under carefully controlled conditions, after which they will be again tested magnetically. The drills are then to be tested mechanically and an attempt made to correlate mechanical performance of the drills with the magnetic tests. The object of the investigation is to develop an apparatus to test drills in a commercial way without destroying them. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

C—RESEARCH PROBLEMS

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

Machine Design C1–21. SHAFTS IN BRONZE BEARINGS. The behavior of steel shafts with various carbon contents when running in bronze bearings is desired. This should refer to friction, wear and similar data. Address S. A. Hand, Associate Editor, *American Machinist*, New York City.

D—RESEARCH EQUIPMENT

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

Scovill Manufacturing Company D1–21. EQUIPMENT. Apparatus for electrical measurements of the following range:

Resistance from 1×10^{-3} ohm to 1×10^{7} ohms.
Inductance from 1×10^{-5} henry.
Capacity from 1×10^{-4} microfarad.
Voltage from 1 millivolt of any frequency.
Current from 0.1 milliampere of any frequency.
Breakdown voltages up to 30,000 volts.

The laboratory is equipped with platinum thermocouples, standard pure metals for melting-point measurements, General Electric oscillograph, complete radio apparatus for generation, study and use of high frequencies; accoustic apparatus, including visual electric noise indicator developed in the laboratory for quantitative, relative indication of loudness of sound, a dictograph loud speaker, a callophone loud speaker, a Winkler-Reichman loud speaker, a magnavox telemegaphone, microphones, receivers, transformers and generators.

Galvanometers, voltmeters, ammeters, wattmeters, inductances, capacities, Wheatstone bridges, capacity bridges, inductance bridges and potentiometers are also found in the laboratory.

The laboratory is equipped with selenium cells, constant-frequency and speed apparatus, an Evershed bridge megger and three electric furnaces.

The laboratory force consists of four technical men, four meter men, one jeweler, one high-grade mechanic, one helper and two apprentices.

The laboratory is located in a two-story brick building, the first floor containing a fully equipped machine shop, special research rooms, several motor-generators and storage space. The second floor contains the meter department, the standardizing, high-current and high-frequency tables and space for miscellaneous testing and special setups with the time-signal apparatus and desk space. The laboratory is provided with 110–220 volt d.c. and a.c. current and 440-volt, three-phase, 60 cycle a.c. current. In addition there is 110-volt emergency storage-battery lighting system and a storage battery for currents up to 500 amperes at three volts. Laboratory apparatus will give constant frequency between 60 and 80 cycles at 110 volts and high frequencies of 1000 cycles and above for small currents. Two-phase current may be obtained at any frequency up to 133 cycles.

The laboratory is used for development of inventions and the perfection of manufacturing methods with the development of theory underlying the action of new electrical apparatus. It makes tests for the Sales Department, for the Purchasing Department and for the Manufacturing Department. It performs technical service regarding time-signal reception for the regulation of the electric-clock system and the maintenance of X-ray apparatus. The service is extended in the Meter Department to the installation, maintenance and repair of electrical switchboard instruments and service meters, pyrometers and thermometers, and the monthly checking of switchboard meters with portable meters which are calibrated periodically against laboratory standards. Address Scovill Manufacturing Company, Waterbury, Conn. Attention R. S. Sperry.

E—RESEARCH PERSONNEL

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

F—BIBLIOGRAPHIES

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. or to others recommended by members of the A.S.M.E. These bibliographies are on file in the offices of the Society.

Metal Manufacturing, Miscellaneous F1–21. FORGING AND FINISHING CLAW HAMMER HEADS. A bibliography of ½ page. Search 3243. Address A.S.M.E., 29 West 39th St., New York.

Petroleum, Asphalt and Wood Products F2–21. BIBLIOGRAPHY OF PETROLEUM AND ALLIED SUBSTANCES 1917. The Bureau of Mines has issued Bulletin 120 giving the Bibliography of Petroleum and Allied Substances for the Year 1917. This may be obtained from the Government Printing Office, Superintendent of Documents, Price 25 cents.

Properties of Engineering Materials F2–21. FLUORSPAR. A bibliography of three pages. Search 3240. Address A.S.M.E., 29 West 39th St., New York.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of MECHANICAL ENGINEERING are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A.S.M.E. affairs.

DeLamater Ericsson Tablet Fund

TO THE EDITOR:

The following subscriptions to the DeLamater Ericsson Tablet Fund have been received from members of the A.S.M.E.:

S. and V. D. Bevin	$10
A. Falkenau	5
A. Hollander	1
D. S. Jacobus	5
D. J. Lewis, Jr	5
J. W. Lieb	10
G. M. Newcomer	10
A. Schein	3
H. R. Towne	50
	$99

Further subscriptions will be duly reported.

H. F. J. PORTER, *Chairman,*
DeLamater Ericsson Tablet Committee.

New York, N. Y.

The St. Lawrence River Project

TO THE EDITOR:

Having read in the correspondence columns of MECHANICAL ENGINEERING and elsewhere much pro and con discussion of this subject, it may be permissible for one who is familiar with the St. Lawrence River to state some facts for the benefit of those who would like to give some consideration to the subject without devoting much time to the question.

Measured as to any one of its qualities, the St. Lawrence is one of the greatest rivers of the world. But, measured as to all its qualities collectively, it is the greatest. From the standpoint of history and discovery it occupies a prominent position. The Gulf of St. Lawrence was probably entered by Norsemen as early as 1000 A.D., the accounts of Lief Ericsson and his followers clearly indicating that they were in the gulf at that date, though the discovery of the river is credited to Jacques Cartier in 1534. Since the time of Champlain, about 1600, it has been a traveled pathway to the heart of North America. To the early explorers and later developers of the continent it was by far the most important pathway. The explorers passed up the St. Lawrence through the Great Lakes, or along their shores, to the plains of the West and down the Mississippi River.

The St. Lawrence River is remarkable for its magnitude, for the stability of its bed, and for its beautiful shores and islands, affording innumerable summer homes for those who love nature. It drains some 300,000 square miles of area, of which 100,000 is water surface of the Great Lakes. Lake Superior is 1000 ft. deep, its bottom reaching 400 ft. below sea level. Such great natural reservoirs give the river a unique status as to the uniformity of its flow and as to the absence of destructive floods. The remarkable clarity and purity of its waters result in large measure from the influence of the lakes.

When it comes to national, in fact international, economics, the St. Lawrence River is superlatively paramount. Though

it now carries a heavy traffic by steamers of 14-ft. draft, limited by the depth of the lock sills in the chain of Canadian canals evading many shallow rapid sections; though there are a number of important water powers now developed, yet the possibilities as to navigation and water power have scarcely been touched. The surface of Lake Ontario is about 245 ft. above sea level and the average available flow is about 220,000 cu. ft. per sec. Thus there are now being wasted in hydraulic friction some 6,000,000 hp., by far the greater portion of which can be recovered by a comprehensive scheme for ultimate expansion which must, by all means, provide for the greatest possibilities of navigation by ocean-going vessels. There must be no mistake as to capacity. It should be determined by a congress of the competent representatives of all the interests and nations concerned.

The importance of the St. Lawrence River and its possibilities to the world in general, and to the evolution of American civilization in particular, is so vast and so intrinsically meritorious that any great and truly comprehensive project will be self-promoting to the point of realization. B. F. GROAT.

Pittsburgh, Pa.

Contends That Monotony Is Not Objected to By Operators on Repetition Processes

TO THE EDITOR:

Mr. Gibbons in the January number speaks of monotony of operation and takes it for granted that operators on repetition processes have difficulty on account of monotony.

So far as I know, there is no evidence whatever to support this view. I have made some personal investigations and find that operators on repetition processes make no complaint whatever regarding monotony. In fact, in many cases, I have seen definite indications that the fact that the operator has to make no mental effort, is considered as a distinct advantage. This seems to indicate that the present system of monotonous repetition work distinctly conserves human life of the average repetition worker.

S. A. MOSS.

West Lynn, Mass.

Music Hath Charms But Not Power

TO THE EDITOR:

I notice in your valuable journal in an article on "Measuring the Two-Hundred Millionth Part of an Inch," on page 59 of your January issue, near the bottom of the 2nd column, there is a repetition of an old fallacy, which ought to have been dead and buried long ago without any possible resuscitation. It occurs in the words: "Many years ago it was stated that it would be possible to wreck the Brooklyn Bridge by means of a violin so played that the vibrations set up would always be in unison with the oscillations of the bridge. Whether this can be done or not is not very important." The plain truth is that it cannot be done, and whoever first inflicted such a statement on the public did not know what he was talking about. I heard this statement repeated many years ago in what purported to be scientific lectures, which to this extent were simply impositions on the credulity of the audience. Any vibrating structure like a bridge is subject to large internal losses by the imperfect elasticity of the structure, and even the turbulence of the air surrounding a large structure in vibration would consume considerable energy, and yet the tiny amount of energy radiated by a violin string—most of which would not even enter the resonant structure but spread into the surrounding void—is supposed to be enough to wreck such a structure as the Brooklyn Bridge. The thing is so absurd that one wonders why this fallacy should ever be repeated in print or in any other way. It is a fantastic statement from beginning to end. Just think of the loud note that the bridge itself would have to utter in unison with the violin before the bridge fell!

ELIHU THOMSON.

West Lynn, Mass.

Milling-Machine Feed Systems

TO THE EDITOR:

In looking into the literature on the subject of milling-machine feed systems I have been much impressed by the lack of systematic investigation and even, frequently, of reasonably straight analysis in connection with the data already at hand. A case in point, not so much connected with the action of a milling cutter as with the functioning of a milling machine, is the question of the two types of feed systems. This was brought more distinctly to the fore by the definite stand taken in a recent article in favor of a machine driven from the spindle.[1] The best current practice has rejected this feed system. The new system of constant-speed feed shaft lends itself to very rigorous demonstration as being in all ways superior to the system formerly in vogue.

There are two different systems of feed mechanisms used in milling machines. The older one has the feed mechanism driven from the spindle of the machine. The modern method uses a separately driven feed shaft running at constant speed.

The following six statements are submitted in logical sequence, some being axiomatic:

1 In discussing the action of milling, *feed per tooth* is the fundamental quantity
2 A large-diameter cutter will have more teeth than a small cutter
3 One tooth in a large face mill will take a heavier cut than a tooth in a small end mill
4 Peripheral speed is approximately constant for a given quality of cutter and of material. It follows that the large-diameter mill will be used in conjunction with slow speeds and small-diameter mills in conjunction with high speeds
5 A large-diameter cutter will call for a larger feed per revolution than a small-diameter cutter does. (See statements 2 and 3.)
6 Slow spindle speeds will call for heavy feeds per revolution and fast spindle speeds will call for light feeds per revolution. (See statements 4 and 5.)

For simplicity consider a machine with four speeds: n, rn, r^2n, and r^3n revolutions per minute. Assume similarly four gear changes in feed box in geometrical progression. When spindle speed is n, let smallest table travel be a inches per revolution of spindle. Let the ratio of successive changes of gears in feed train be s. For simplicity s and r may be assumed equal, as is often approximately the case, and Tables 1 and 2 may be obtained, giving the table travel per revolution of spindle for the above conditions under each of the systems.

TABLE 1 MILLING-MACHINE FEEDS: FEED SHAFT DRIVEN FROM SPINDLE

Spindle Speeds	Feed Per Revolution			
n	a	ra	r^2a	r^3a
rn	ra	r^2a	r^3a	r^4a
r^2n	r^2a	r^3a	r^4a	r^5a
r^3n	r^3a	r^4a	r^5a	r^6a

TABLE 2 MILLING-MACHINE FEEDS: CONSTANT-SPEED FEED SHAFT

Spindle Speeds	Feed per Revolution			
n	a	ra	r^2a	r^3a
rn	$\frac{a}{r}$	a	ra	r^2a
r^2n	$\frac{a}{r^2}$	$\frac{a}{r}$	a	ra
r^3n	$\frac{a}{r^3}$	$\frac{a}{r^2}$	$\frac{a}{r}$	a

By an analysis of the two tables the following points may be observed:

a In both systems the feed gear box gives a flexibility with the lowest spindle speed from a to r^3a inches feed per revolution of spindle
b In machine with feed train driven from spindle a feed per revolution of r^3a to r^6a is given with highest spindle speed
c In machine with constant-speed feed shaft, a feed per revolution of a down to a/r^3 is given with highest spindle speed.

In conclusion it may be stated that if a be adjusted in each case to make machines equally good with lowest spindle speed, then the constant-speed feed shaft machine has a region of finer feeds

[1] Supplement to Frederick W. Taylor's "On the Art of Cutting Metals," Carl G. Barth, *Industrial Management*, July 1920, pp. 49–52.

per revolution available with the highest spindle speed, whereas the other machine has coarser feeds per revolution available with the highest spindlespeed. This is just the reverse to requirements. (See statement 6.)

Similarly, if a be adjusted to make the machines equally advantageous with highest spindle speed, the machine with spindle-driven feedshaft would have inefficient slow feeds per revolution at the lower spindle speeds.

The constant-speed feed shaft projects the total flexibility furnished by the gear box into the region where needed. The spindle-drive machine does not, so a large part of the flexibility furnished by the gear box is wasted.

A study of the two tables bears out the following statement: If the same range in useful feed per revolution is insisted upon in both machines, then the spindle-driven machine must be furnished with *seven changes of feed gears instead of four*, namely, a/r^3, a/r^2, a/r, a, ra, r^2a, and r^3a, or r must be increased to p, say, where $p^3 = r^5$, or $p = r^2$, with a corresponding decrease of efficiency, of course.

The writer believes that there is no single tenable argument in favor of the machine with the feed mechanism operated from the spindle. Current practice would indicate that this is being more and more appreciated by leading milling-machine manufacturers.

JOHN AIREY.

Ann Arbor, Mich.

Appraisal Principles Applied to Industrial Properties

TO THE EDITOR:

A careful perusal of such articles concerning appraisals and valuations as have come to the attention of the writer within the past two years, has led him to the conclusion that opposite principles are in use by different engineers, and, moreover, that nearly all such articles deal only with one class of property to be appraised or valued, namely, public-utilities companies.

Within the period embraced from the signing of the armistice to the present day, business men and executives have had their attention focused on valuation of their property for many reasons, a principal one of which was the settlement of Government contracts, another the excess-profits taxes, and another the rapid rises in replacement costs of plant or equipment necessitating readjustment of insurance. Nearly all of these valuations fall within the industrial class. Some confusion exists in the minds of the average business man concerning the terms used by all in appraisal work. The writer would like to define an appraisal as "a measure of economic worth," and in explanation of this statement explain that the common medium or standard of this measure is money.

For the purpose of this discussion the division of appraisals into two classes is made so that a comparison may be readily instituted and in order to show that the governing principles of the appraisal as applied to the two divisions vary somewhat. The divisions consist of public-utility properties and industrial properties.

To ascertain just what should govern the appraisal, an examination of the use to which the appraisal is to be put should be made. With this end in view, the writer enumerates the principal uses of appraisals, either public-utility or industrial, as follows: They are as a basis for, first, establishing rates for service or product second, charges for depreciation and depletion; third, tax returns, federal, state, and municipal; fourth, amounts of insurance to be carried; fifth, issuance of bonds or capital stock; sixth, mergers or consolidations; seventh, bank credits; eighth, purchase, sale or lease of property; ninth, settlement of estates; tenth, settlement and adjustment of partnerships; eleventh, court decisions.

An analysis of the reason for the first use in connection with a public utility discloses that it is made invariably for the securing of a fair rate of return on the investment to the stockholder or bondholder, while in the case of its use by an industrial concern it is desired, in order to obtain a fair rate of return on the investment and in addition so that the concern may be in a position to secure the maximum rate possible under existing economic conditions. Therefore an appraisal of the property for this purpose in the case of public utility is usually based upon first cost, while in the case of an industrial company two appraisals may be made, the first on a basis of original cost and the second on a cost of reproduction of like plant today, new and under existing conditions. There has recently been handed down a decision by Judge Valkenburgh of the U. S. District Court, Kansas City, Mo., against the Missouri Public Service Commission enjoining them from enforcing a rate based on original cost on the grounds that the commission's original cost basis was in violation of the fourteenth amendment to the Constitution. Whether or not this decision by the Circuit Court will be upheld by the Supreme Court remains to be seen.

An examination of the second use—whether for public utility or industrial property—leads the writer to reason that if the appraisal is to be in conjunction with another it should be made upon the same basis as the appraisal it is to be used with, except in the case of Federal taxes noted below.

In the case of an appraisal for the third use, either public utility or industrial, only the first subdivision, Federal taxes, will be dealt with. We are here confronted by a law modified and restricted by decisions from the Treasury Department, which, roughly, may be summarized as follows: "Cost at date of acquisition shall be used; if cost is not ascertainable a fair value as of March 1, 1913, is to be used."

The first portion of the quotation from the revenue act quite clearly indicates that cost is the controlling element as of the date of building or purchase and that any rise in value was not intended to be considered. For the purpose of establishing depreciation rates in connection with Federal taxes, the fair value as of March 1, 1913, may be used. It may be well to state that under the restrictions of the revenue act as generally interpreted, the use of the word "appraisal" is erroneous. In reality, for the purpose of addition to capital an inventory at cost is the allowable use. But for the purpose of establishing a depreciation rate an appraised fair value as of March 1, 1913, of such inventory is used.

Space limitations will not permit the enumeration of appraisals as effected for use as a basis for the various state and municipal taxes, as there are many different regulations by different states and cities.

In the case of the fourth use, whether utility or industrial, it would seem ridiculous for any business concern to insure for its cost, when today the money derived from insurance would replace one-half or one-quarter of the plant. Therefore, the only basis the writer can see that is fair is one that is based on present reproduction under today's existing conditions, taking into consideration future prices during the period to be covered by the policy.

An analysis of the fifth use quite properly shows that the bondholder would wish to know the present value of the property behind his bond. He is only relatively concerned with the past cost but is most intimately concerned with its future value, and so likewise is the stockholder. Both bondholder and stockholder are concerned also with the company's earning power, and therefore to the writer's mind an appraisal falling under this class should be based on a cost of reproduction of the property under existing conditions and prices, keeping in mind any probable fall or rise in prices affecting its reproduction value in the future and as a further governor of value a very close examination of its future earning power.

Quite obviously the purpose of the sixth use of an appraisal for the merging or consolidation of either public utilities or industrial companies is to give each its relative present worth, measuring both in cost to reproduce today and in earning capacity. It should be easily seen that one company may have cost originally more but can be replaced cheaper today than another on account of changes in local conditions, and therefore the only correct basis of appraisal is on cost of reproduction today.

Bankers are concerned when using an appraisal the same as the seventh with, first, the present cost of the property and earning power, and second, the future value. The first cost to them is largely a gage of the growth of the concern, and while perhaps

called for in special instances, is not the fair basis to appraise upon. It is the writer's opinion that today's basis of value is the only one proper to use.

An examination of the eighth, ninth and tenth uses shows that they fall quite naturally into the same class as the fourth. The purchaser of a property will naturally be governed in his purchase by the reproduction of a like property under existing conditions today, that is, present cost. Should he fail to be offered the property at or near this cost he could very obviously build himself, whereas the seller is concerned with getting the worth of his property today as may be governed by existing economic conditions. These same reasons may be said to apply to an appraisal for the leasing of a property or the settlement of an estate or a partnership.

The eleventh use of an appraisal, as a basis of court decisions, will be governed as to whether it is based on first cost or present cost by its application. This may be illustrated by an example: If condemnation of property were made in the year 1918, the appraisal in this case would be based on cost as of 1918, for obviously if as of 1910 it would be unfair to the one who would receive the damages, and if as of 1920 unfair to the one who was to pay such damages.

JAMES S. BROWN.

New York City.

A Plea for Proper Setting of Double-Reduction Marine Gears

TO THE EDITOR:

The following data were taken on board the S. S. *Carenco* en route from Glasgow to Baltimore in ballast: Mean draft, 14 ft. 11 in.; draft forward, 11 ft.; aft., 18 ft. 10 in.; length of hull, 401 ft.; beam, 54 ft.; full draft, 24 ft. 6 in.; deadweight tonnage, 7825; equipped with General Electric turbine and double-reduction gears of 2500 shaft hp.; engine speed, 3234 r.p.m.; gear reduction, 35.9 to 1. The gear on which this check was made was 12 ft. 4 in. in length by 8 ft. 6 in. wide on the foundations.

Due to the considerable difficulty experienced in the operation of double-reduction marine gears for propulsion, a number of theories have been advanced for the cause of failure in the gear teeth. I will not attempt to enter into a discussion of the merits of the various theories, but simply give the results obtained that we may more fully appreciate the conditions under which these gears have to operate.

In order to obtain the figures given in Table 1, a tram was constructed with a revolving head similar to an engineer's transit, and equipped with a seamless drawn tube extending in opposite directions 7 ft. from the center, this tubing being trussed with piano wire to make it as nearly rigid as possible. This apparatus was secured to a pad bolted to the center of the gear-case cover. When the arms were swung diagonally across the gear case, a pin gage to which was attached a Starrett indicator was used at each corner of the gear, two engineers taking the readings between the corner of the gear-case frame and the under side of the bridge arm simultaneously.

The readings given in the table indicate the total deflection of the corner of the gear case, both above and below its normal line, each being an average of five readings taken in succession. After two diagonally opposite corners had thus been checked, the bridge arm was swung to the remaining corners and a similar check was made. It will be noted that there are three readings taken on November 9; in each case the ship was swung off her course to bring the sea on the port and the starboard bow as indicated, and in each case the deflections are the greatest in the gear case in the direction of the progress of the sea under the hull of the ship. It will also be noted that for the readings taken on November 16 and 17 the wind and sea conditions are exactly reversed and that in each case the deflections are the greater on the windward side of the ship.

It is also readily seen from the two sets of readings taken on November 17 that as the sea increases the deflections in the gear case increase in proportion. Also the readings taken on November 18 plainly show that the long swells which succeed a strong wind cause deflections fully as great as when the ship is operating in a storm. The readings taken on November 20 were after the ship had entered Chesapeake Bay, where no wind or sea was encountered, and serve to show the accuracy of the instrument with which these checks were made.

While this ship was en route from Baltimore to Glasgow in loaded condition, very heavy following seas were encountered, in some cases running as high as 20 ft., at which times deflections of 0.050 in. were recorded. When gears of this type are so mounted that deflections of the kind under consideration occur, the case is so warped that the pinions are thrown at an angle with the driving face of the gear; and at a time when the overload becomes 100 per cent, due to surges of sea on the propeller, and with about 50 per cent of the pinion face bearing on the gear face there is an overload on the driving face of the teeth of 400 per cent, this occurring approximately every eight seconds.

TABLE 1 DEFLECTIONS OF GEAR CASE OF DOUBLE-REDUCTION GEAR ON BOARD S. S. "CARENCO" UNDER VARYING CONDITIONS OF SEA AND WIND

Date	Direction of Sea	Direction of Wind	Condition of Sea	Condition of Wind	Ship Riding	Deflection in Inches: Port Forward	Starboard Forward	Port Aft	Starboard Aft
11-6-20	Stb. bow	Stb. bow	Moderate	Moderate	Rolling and pitching easy	0.014	0.020	0.012	0.022
11-7-20	Dead ahead	Dead ahead	Rough	Fresh	Pitching	0.016	0.024	0.014	0.024
11-8-20	Dead ahead	Dead ahead	Moderate	Fresh	Rolling easy	0.017	0.008	0.014	0.012
11-9-20	Dead ahead	Stb. bow	Heavy long swell	Light	Pitching	0.017	0.022	0.028	0.017
11-9-20	Port bow	Dead ahead	Heavy long swell	Light	Pitching and rolling	0.022	0.014	0.017	0.027
11-9-20	Stb. bow	Stb. side	Long heavy swell	Light	Rolling and pitching	0.015	0.025	0.022	0.016
11-10-20	Stb. side	Port bow	Moderate swell	Gentle breeze	Rolling easy	0.013	0.022	0.010	0.023
11-11-20	Stb. side	Port bow	Very light swell	Very light breeze	Rolling very easy	0.005	0.005	0.006	0.008
11-12-20	Stb. bow	Stb. bow	Calm—very light swell	Very gentle breeze	Steady	0.003	0.006	0.005	0.005
11-13-20	Port bow	Port bow	Moderate	Moderate breeze	Rolling and pitching easy	0.013	0.012	0.010	0.011
11-14-20	Dead ahead	Port bow	Moderate	Moderate breeze	Pitching easy	0.014	0.012	0.012	0.014
11-15-20	Astern	Stb. quarter	Moderate	Moderate wind	Rolling and pitching	0.017	0.020	0.015	0.025
11-16-20 A.M.	Stb. side	Stb. side	Gentle sea	Gentle breeze	Rolling very easy	0.009	0.010	0.011	0.012
11-17-20 P.M.	Port side	Port side	Moderate	Light wind	Rolling easy	0.015	0.011	0.015	0.010
11-17-20 A.M.	Port bow	Port side	Rough	Strong wind	Rolling and pitching heavy	0.035	0.022	0.035	0.021
11-18-20 P.M.	Dead ahead	Dead ahead	Rough	Gale	Pitching and pounding	0.023	0.025	0.029	0.022
11-18-20	Dead ahead	Dead ahead	Long swell	Light breeze	Rolling and pitching	0.024	0.027	0.022	0.030
11-19-20	Stb. bow	Stb. bow	Light sea	Light breeze	Rolling easy	0.005	0.007	0.006	0.006
11-20-20	No sea	No wind	No sea	No wind	Steady	0.002	0.002	0.002	0.002

To obtain a marine gear that will be entirely successful, therefore, it must, in my judgment, be mounted in such a manner that the deflections of the hull will not be transmitted to the gear case.

S. K. FRENCH.[1]

Hog Island, Pa.

Manganese steel, the invention of Sir Robert Hadfield—to whom the John Fritz Medal for 1921 has been awarded, even after special heat treatment is so hard and tough that it can only be machined by grinding. This is slow and costly, an article in the *American Machinist* of January 13, 1921, stating that it is the average occurrence for an 18-in. abrasive wheel with 2-in. face to wear away at the rate of one inch of diameter per hour of use. Wheels are usually run at a peripheral speed of 5000–6000 ft. per min., a feed of from $\frac{1}{4}$ to $\frac{1}{2}$ in. per revolution of the work, and a depth of cut of from $\frac{1}{64}$ to $\frac{1}{100}$ in. The wheels best suited for such work are from 10 to 24 in grit and from M to T in grade.

[1] Gen. Supt., Propulsion Machinery Dept., American International Shipbuilding Corporation.

WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval after which it is issued to the inquirer and simultaneously published in MECHANICAL ENGINEERING.

Below are given the interpretations of the Committee in Cases Nos. 312, 313, 318, and 322 to 330 inclusive, as formulated at the meeting of December 6, 1920, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

CASE NO. 312 (Reopened)

Inquiry: Is it necessary in the construction of small Star-type water-tube boilers for steam heating which are to carry more than 15 lb. pressure at times, to drill the inside and outside ends of staybolts? It is believed that it was the intent of the Committee to cover in this requirement the waterlegs at front and back ends which are considered as headers.

Reply: If the grate area is more than 15 sq. ft., the staybolts are less than 8 in. in length, and the pressure exceeds 15 lb., it will be necessary to drill the staybolts in order to comply with the Code requirements.

It is the opinion of the Committee that the staybolts in the side sheets and that portion of the tube sheets below the tubes of boilers of this type, need only be drilled on the outside ends as required in a boiler of the locomotive type, but that the staybolts in that portion of the tube sheets containing the tubes should be hollow or drilled at both ends as required for the waterlegs of water-tube boilers.

CASE NO. 313

Inquiry: Is it permissible, under the requirements of Par. 186 of the Boiler Code, to join by autogenous or fusion welding the butting edges of flanged plates to form the waterlegs of detached smokeless fireboxes, where the stress due to the steam pressure is fully carried by staybolting?

Reply: The welded construction described is allowable under the rules of the Code provided the strength of the structure is sufficient to meet the Code Rules without making any allowance for the holding power of the weld.

CASE NO. 318

Inquiry: Is it permissible, under Par. 331 of the Boiler Code, to omit the stamping from completed shells of miniature boilers which are formed by a cupping or hot-drawing process in which the stamping is necessarily obliterated?

Reply: It is the opinion of the Committee that the intent of Par. 331 would be met if a record of the heat numbers taken from the plates were checked with the mill test reports, and if found to meet the Code requirements, the inspector may authorize the manufacturer to proceed with cupping the plates, after which the manufacturer is to stamp the shell, in the presence of the inspector, with a lot number which will identify the sheet with the test sheet record.

CASE NO. 322

Inquiry: What material is it necessary to use under the requirements of the Boiler Code for the Y-fitting, also for the safety-valve body, for safety valves to be operated at a pressure of 225 lb.? May cast iron be used for this purpose?

Reply: Under the requirement of Par. 9 it is necessary that the Y-fitting be constructed of steel, but the safety-valve body need not be of steel unless to operate with superheated steam (see Par. 289).

CASE NO. 323

Inquiry: Does Par. 380 cover all classes of lap-seam boilers including boilers of the locomotive type, or does it apply solely to h.r.t. boilers? Is it the intent of the Boiler Code that the drums of water-tube boilers over 36 in. in diameter and over 20 years of age come under the requirements of Par. 380?

Reply: It was the intent of the Committee that the application of Par. 380 should be limited to h.r.t. and similar types of fire-tube boilers, the shells of which are exposed to the fire or products of combustion. It was not intended that Par. 380 should apply to the drums of water-tube boilers, or boilers of the locomotive type.

CASE NO. 324

(In the hands of the Committee)

CASE NO. 325

Inquiry: Is it necessary in existing installations that, under the requirements of Par. 315, the feedwater delivery pipe shall be carried through the shell of an h.r.t. boiler near the front end in all cases? With scale-forming water it is found that with the delivery pipes carried through the shell near the back end, they could be easily removed for cleaning out scale, etc.

Reply: Attention is called to the fact that Par. 315 appears in Part I, Section I, of the Boiler Code and therefore does not apply to existing installations.

CASE NO. 326

(Annulled)

CASE NO. 327

Inquiry: Is it necessary, under Par. 430d, that the fusible plug must be located in a tube not less than one-third the length of the tube above the lower tube sheet where such a boiler is fitted with an extra head and a water-heating compartment at the top of the shell?

Reply: It is the opinion of the Committee that where a top compartment is utilized for preheating of feedwater, the measurement of the tube may be construed as applying to that portion of the tube between the firebox tube sheet and the point where the tube enters the top compartment.

CASE NO. 328

(In the hands of the Committee)

CASE NO. 329

Inquiry: What tensile strength shall be used for the calculation of the maximum allowable working pressure of pressure parts formed of steel castings of Class B grade or of seamless steel tubing material?

Reply: It is the opinion of the Committee that the tensile strength used in the calculation of pressure parts formed of steel castings of Class B grade or of seamless steel tubing shall be the minimum tensile strength determined from tests made on the test specimens located and taken as given in Par. 88 of the Code.

CASE NO. 330

Inquiry: Is it permissible to repair cracks in the tube sheets of water-tube boilers by autogenous or fusion welding? In the recommendations in the Appendix it is stated that no welding shall be allowed in cracks in shell plates or other plates subject to tensile strain, yet it is stated that where tube sheets of boilers have deteriorated not to exceed 25 per cent of their original thickness, the same may be reinforced and repaired by any process of autogenous welding.

Reply: It is the opinion of the Committee that such process of reinforcing and repairing may only be used on tube sheets which are not subject to tensile strain, as permitted by the Appendix.

Plans for Organizing the Port of New York

Automatic Electric Subway to Eliminate Surface Congestion and Reduce Handling Cost

THE terminal problem of New York City has an important bearing on national industry and transportation. A report presented to the governors of New York and New Jersey by the New York, New Jersey Port and Harbor Development Commission should be of great interest to engineers. Briefly the recommendations of the Commission are as follows:

1 Adoption of a compact between the states of New York and New Jersey providing for the creation of a single port district administered by a single port authority

2 Construction of an automatic electric system connecting the trunk-line railroads with terminal stations in Manhattan for the distribution and collection of general merchandise, freight, and food products

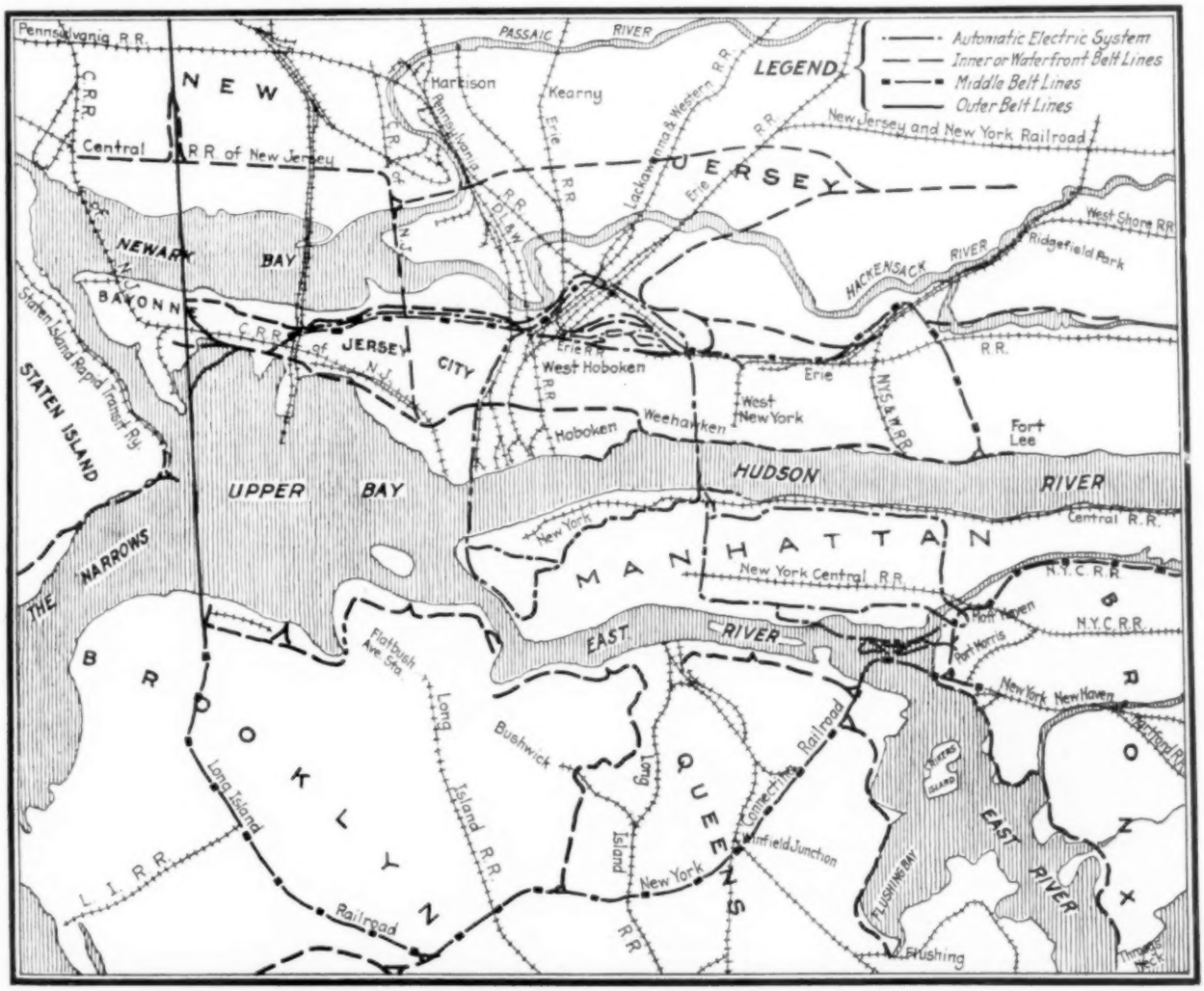
3 Development of a standard belt-line railroad system for all parts of the port except Manhattan, embracing inner or waterfront belt lines in New York and New Jersey, middle belt lines in New York and New Jersey, and an outer belt line in New Jersey

4 Consolidation of railroad marine operation not eliminated by the automatic electric and extended rail service, with separate joint railhead terminals for car-float service and lighterage.

Further recommendations are made concerning food-receiving stations and terminal markets in Manhattan and the Bronx, provision of waterfront piers, warehouse facilities, dredging of channel, modifying bridges, zoning of steamship terminals by trade routes, construction of grain elevators, and the establishment of free ports in the port district.

The most pressing element in the problem is the service to and from Manhattan Island itself. This problem is complicated by the need for eliminating the New York Central tracks at the grade on the west side of Manhattan and the congestion which prevents the bringing of freight cars to the sidings of the shipper and consignee.

Before reaching its final decision, the Commission gave careful consideration to:



MAP SHOWING PROPOSED BELT LINES AND AUTOMATIC ELECTRIC SYSTEM

a Railroads for standard rolling stock, both elevated and below ground

b Motor-truck service between New York and New Jersey similar to the Cincinnati trap-car system

c Cableway truck-conveyor system

d Improved water transfer service.

The plan evolved will release the Hudson River and New Jersey waterfronts from pier-station occupancy, will dispose of the New York Central's surface tracks, will provide ample capacity for the future and effect a large saving in terminal cost. This system, known as the Automatic Electric, will resemble a railroad but will function as a conveyor, electric circuits being used to hold the trains in fixed position with respect to each other. The elements of the systems are a belt-line railroad in New Jersey reaching all

(Continued on page 220)

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

29 West 39th Street, New York

EDWIN S. CARMAN, *President*
WILLIAM H. WILEY, *Treasurer* CALVIN W. RICE, *Secretary*

PUBLICATION COMMITTEE:
GEORGE A. ORROK, *Chairman* RALPH E. FLANDERS
GEORGE J. FORAN ALEX. G. CHRISTIE
JOHN T. WILKIN

PUBLICATION STAFF:
LESTER G. FRENCH, *Editor and Manager*
FREDERICK LASK, *Advertising Manager*

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

C 55 The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

Recent Hydraulic Development on the Pacific Coast

ROBERT SIBLEY

EVER since the announcement was made at the Pasadena Convention of the National Electric Light Association by the Water Power Development Committee last spring that a program of expenditure amounting to $700,000,000 must be put under way immediately in the West for a ten-year development period, there has been a considerable stir throughout the nation in following the Pacific Coast situation. The year just brought to a close has seen more than this program outlined put into operation. Below is a summary of the present status of this work. The report of the California Railroad Commission shows that this state alone has issued some $60,000,000 in hydraulic securities during the past year under the approval of the Railroad Commission.

It is interesting to note some of the outstanding features of this development, as a number of records are being established. At the Kern River No. 3 power plant of the Southern California Edison Company are being installed two Pelton reaction turbines of 23,500 hp. capacity operating under a head of 802 ft. On the Pit River development of the Pacific Gas and Electric Company are being installed two 40,000-hp. turbine units of the Allis-Chalmers design. The Great Western Power Company in its Caribou plant is putting into service this month transmission of hydroelectric energy at 165,000 volts over a distance of 190 miles. Both the Pacific Gas and Electric Company and the Southern California Edison Company have under way the installation of 220,000-volt long-distance transmission. The copper for the Pit River development of the Pacific Gas and Electric Company, which is to operate at 220,000 volts, has recently been ordered from the Anaconda Copper Mining Company of Great Falls, Mont. The finished cable will have a 500,000-circular mil cross-section made up of seven conductors, seven-rope lay strand, and it is the largest rope strand which the company has had to build. Something over ten million pounds of copper will be required and it will require approximately two hundred freight cars or about eight average-size freight trains to haul the finished order.

It is impossible to go into detail in a brief sketch such as this in regard to the many interesting features, or even to outline the gigantic power program that is under way in the West. A general conception of its magnitude, however, may be gleaned from the fact that the Southern California Edison Company in its sworn statement before the California Railroad Commission states that it will complete its Big Creek development within the next fifteen years, developing a total of something over 800,000 hp. at a cost of $200,000,000. This energy is to be transmitted into Los Angeles at a distance of 240 miles over a 220,000-volt circuit. The company is now under active construction of this program and the first units in this new development will be put into commission during the current year. This same company has quite recently made announcement of the taking out of water rights on the Colorado River which will necessitate the building of a dam 500 ft. high and which will bring about the storage of 40,000,000 acre-feet. As the largest storage reservoir in the western hemisphere now stores but something like 2,600,000 acre-feet, being that of the Elephant Butte Dam in New Mexico, it is readily seen to what gigantic proportions such a development may arrive. The conservation of this water will bring about the development of 4,200,000 hp. By leaving out the Grand Canyon of the Colorado, the company expects to develop 2,500,000 hp.

The four principal companies that are now under active operation in development work in California are: The Southern California Edison Company, The Pacific Gas and Electric Company, The Great Western Power Company and the San Joaquin Light and Power Corporation, in addition to the work of the city of San Francisco and the city of Los Angeles.

The accompanying tabulation gives brief particulars regarding the outstanding features of the present development. It does not, however, give the completed capacity of all the plants that are in the proposed schedule of development, but only those that are actually now under way in construction.

ELECTRIC PLANTS UNDER CONSTRUCTION IN CALIFORNIA

Plants	Capacity in Kw.	Type	Expected Date of Completion
Great Western Power Co.:			
Caribou: Feather River (2 units)	40,000	Hydro	Apr. 1921
Pacific Gas and Electric Co.:			
Oakland	12,500	Steam	Jan. 1921
Hat Creek No. 1	6,100	Hydro	Apr. 1921
Hat Creek No. 2	8,200	Hydro	Apr. 1921
Fall River	44,300	Hydro	Mar. 1922
Spring Gap: Stanislaus River	7,500	Hydro	July 1921
City of San Francisco:			
Moccasin Creek (3 units)	49,500	Hydro	Jan. 1923
Southern California Edison Co.:			
Big Creek No. 2: 3d unit	16,500	Hydro	Dec. 1920
Kern River No. 3	30,000	Hydro	Feb. 1921[1]
Big Creek No. 8	22,500	Hydro	Aug. 1921
San Joaquin Light and Power Corpn.:			
Midway	12,500	Steam[2]	Apr. 1921
Kern River	8,250	Hydro	July 1921
Southern Sierras Power Co.:			
Owens Auxiliary	2,500	Hydro	Feb. 1921
Levining Creek	2,500	Hydro	Oct. 1922
Los Angeles Gas and Electric Corpn.:			
Los Angeles	10,000[3]	Steam	Jan. 1921
City of Los Angeles:			
San Fernando	7,000	Hydro	Jan. 1921
Franklin Canyon	2,500	Hydro	Jan. 1921
Total	289,850		

[1] First unit. [2] Gas fuel. [3] Limited to 7500 kw. on account of boilers.

The power shortage in California seems to be unabated, even though new developments have been put in during the past year. It would seem that the growth of the state, proceeding at the rate of about 44 per cent during the ten-year period, is bringing about such increased agricultural and industrial development that the power program will need exerted upon it all the energy possible in the way of financial support in order to satisfy the insistent demand for power on all sides. A great effort is being made throughout California and the West to put the problem before the public itself in order that it may see the necessity of backing up the various utility companies in their efforts to acquire the necessary financing that this program may go ahead unhampered.

ROBERT SIBLEY.

San Francisco, Cal.

Labor as a Business, Not a Commodity

The contract system in vogue in New England machine shops in the early days undoubtedly was effective in pulling down costs of production, but so far as the interests of the workmen were concerned, it was but a revival on a small scale of the old medieval system of farming out the taxes—a system which was sometimes satisfactory to the tenants, but more often was not.

Chordal's letters, written in the days of the contract system, tell how the Yankee contractor "Doolittle" produced remarkable results in the Western engine shop of "Pete and Cady." "Doolittle sails in," says the account. "The engine work is in his hands; the men are his. He pays them. He stops every man of them and sets them to work on tools, fixtures, jigs, etc., and keeps them there for a month. Doolittle goes through every piece and cuts the price down and the men's earnings up."

This is an optimistic view so far as the men are concerned. In too many cases the contractor adopted sweatshop methods and cut the men's earnings *down*. The real rub, however, is explained by Chordal, who intimates that Pete and Cady felt a bit sore at the profits Doolittle was making. They exclaimed: "We would think we were going to the dogs if we paid a superintendent the money as salary which Doolittle the contractor gets as profit."

In an article on Labor as a Business, Not a Commodity, in the *Manufacturers Record*, by George H. Cushing, Washington representative of the American Wholesale Coal Association, another scheme for contracting for labor is set forth which at least has the advantage of removing the objections to the older scheme which were due to the letting of contracts to individuals. It is, instead, to let the contract for labor to the men as a body, both manufacturer or operator (he is speaking of coal mining) and the contractor being incorporated and equally responsible under the law. For example:

> The coal-mine operator has, we will say, a proved productive capacity of 100,000 tons per month. He sells on contract 60 per cent of that output, or 60,000 tons per month. He can—with the same safety he moves in other directions—sign a contract for the labor to produce 60,000 tons a month. That is, he can, to that extent, contract with his men to give them that measure of a minimum wage and a minimum working time. . . . . The operator, having received the labor as a unit, should pay for it as a unit. That is, only one pay check should pass. The employing company should pay the employee company for the labor even as it pays any other business house for its product. The employee company should distribute its own funds.

Mr. Cushing contends that "labor is *not a commodity*. . . . . it is an act of production. Production is a business. For that reason, labor is a business. The main difficulty is that labor has not been organized—as a business." He holds, however, that labor is generally regarded as a commodity to be bought in the open market at the lowest price, the same as machinery or any other commodity is bought. While acting on that theory capital has paid labor for results only, often on the piece-work basis, and soon after came the cuts in piece-work rates and the many other points of contention that have given rise to so much strife. He says:

> Labor felt outraged. It believed that it was tricked. Perhaps it was. Even so, it had no different treatment than was customarily given to other producers of raw material. Instead of organizing for business defense as other producers had done, labor organized a voluntary union to fight it out along lines of reprisal. So labor came to stand firmly against any proposal to accept payment for results only. It demanded payment for time spent, regardless of results. Thus the issue was drawn. Labor demanded payment for time spent only. Capital offered to pay for results only. The two could not possibly have maneuvered themselves into positions farther apart. And each side began to organize its forces to impress its view upon the other. This building of competing organizations has been going on for 40 years. The organized movements on both sides have taken on a variety of names, but the animating purpose on both sides has remained constant.

With the sudden collapse of the tremendous demand for workers and the state of flux into which labor has lately been thrown, Mr. Cushing believes that the time is ripe for a new deal—perhaps a new labor organization, not a replica of the old, built upon hatred and with a lack of principles, but an organization built along business lines; and that labor will go into business as, incidentally, he says, it should have done 25 years ago. Perhaps labor will be organized "as a business" instead of remaining simply a "commodity."

An obvious question to ask is, Will the union that is to be incorporate? Will its members risk a contract where there is a chance to lose as well as a chance to gain? Labor has never done it in the past. The one thing it has demanded has been a steady job at fair pay, with no risk and small responsibility.

As keen an analyst of labor conditions as Lord Leverhulme, the English manufacturer and economist, compared the workmen in his view of the desirability of a steady wage without possible loss, to the English debenture holder who says: "I do not want big profits; I want an assured rate of interest with absolute security. I would rather have a sure 4 per cent or 4½ per cent than I would the ordinary shares with a possible 10 per cent or a possible nothing; therefore, give me debenture."

National Board of Boiler and Pressure Vessel Inspectors

The first annual meeting of the National Board of Boiler and Pressure Vessel Inspectors brought together at the Hotel Statler in Detroit on February 2, 3 and 4 a group of about sixty men, including members of the Board itself, members of the Boiler Code Committee of The American Society of Mechanical Engineers, and others interested.

The first day was devoted to the hearing of addresses. Dr. D. S. Jacobus, acting chairman of the A.S.M.E. Boiler Code Committee, told of the genesis and development of the Code, emphasizing the fact that no action had been taken without consideration of the interests of all who were involved in the questions under discussion.

Charles E. Gorton, chairman of the American Uniform Boiler Law Society, told of the appointment of the first Boiler Code Committee by Col. E. D. Meier, when he was president of The American Society of Mechanical Engineers, how the Society had reached the limit of its functions in the formulation and interpretation of the Code, and the Uniform Boiler Law Society had been organized to promulgate it, and how the National Board of Boiler and Pressure Vessel Inspectors had been organized at the instigation of the American Uniform Boiler Law Society. He told of seeing on his recent trip to the Coast a boiler with the stamps of 22 different states upon it, which absurd practice, now not uncommon, would be avoided by the facilities and simple procedure offered by the organization of the National Board.

Of the other speakers E. R. Fish, vice-president of the Heine Safety Boiler Company, explained still further the advantage of a single stamp for boilers constructed in accordance with the Code. S. F. Jeter, chief engineer of the Hartford Steam Boiler Inspection and Insurance Company, spoke upon the advantages of uniform qualifications for boiler inspectors. F. R. Low, editor of *Power*, outlined some of the possibilities, opportunities and responsibilities before the National Board.

J. C. McCabe, commissioner of the city of Detroit, and chief inspector of boilers for the state of Michigan, spoke of the qualifications and duties of boiler inspectors.

On the second day the members of the Board attended a meeting and took part in the deliberations of the Boiler Code Committee of The American Society of Mechanical Engineers. This meeting of the Committee was held at Detroit instead of, as usual, at the headquarters of the Society in New York, in order to give the Committee the advantage of meeting and counseling with the men from all over the country who are enforcing the Code. Nineteen inspectors were present from almost as many different states in widely separated sections of the country.

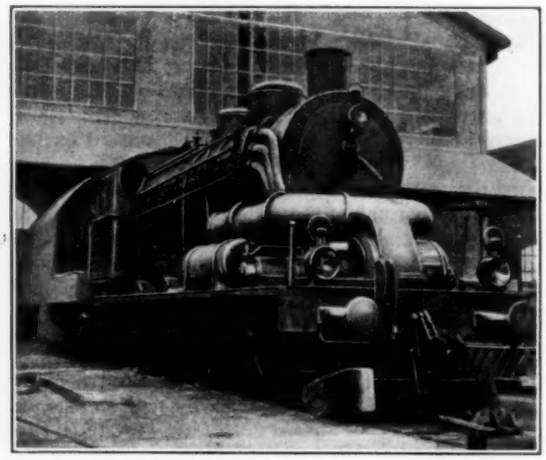
The objects of the Board of Boiler and Pressure Vessel Inspectors as stated in the Constitution adopted are as follows:

> To promote uniform boiler laws and rules throughout the jurisdiction of its members.
>
> To secure uniform approval of specific designs of boilers and other pressure vessels, as well as appurtenances and devices used in connection with their safe operation.
>
> To promote one uniform code of rules and one standard stamp to be placed upon all boilers constructed in accordance with the requirements of that code, and one standard of qualifications and examinations for inspectors who are to enforce the requirements of said code.
>
> To compile official statistics and other data.

Steam-Turbine Locomotive

When William Avery (who, by the way, was a relative of the late John E. Sweet) built his Hero reaction steam turbines nearly ninety years ago and used them for operating sawmills and woodworking shops in New York State and elsewhere, he took a chance at trying out one for the motive power of a locomotive on the Newark, N. J., meadows. Mr. Sweet has described the turbine as having a 7-ft. arm which rotated at enormous velocity and had a speed at its tips of $14\frac{1}{2}$ miles per minute. It is not surprising that the machine ended its life in a ditch beside the track.

From that day to this there has been comparatively little effort to apply the steam turbine to locomotives. According to the *Railway Gazette* of London, however, a turbine-driven locomotive is now being tried on the Swiss Federal Railways. It is converted from a standard 4-6-0 type as used on the Federal Railways. The



EXPERIMENTAL TURBINE LOCOMOTIVE, SWISS FEDERAL RAILWAYS

turbine is reversible and is placed in front of the smokebox, power being transmitted by 30 to 1 gearing to a horizontal crankshaft placed above the leading truck, the rods of the six coupled wheels being extended forward and connecting with the crankpin at each end of the crankshaft.

The engine is designed for a turbine speed of 8000 r.p.m., giving a running speed of 49 miles an hour. The boiler is equipped with a superheater and a condenser is fitted below it, utilizing water from the tender, to which latter it is returned for cooling by being allowed to fall in narrow streams from the roof extending over the tender, which is designed for the purpose. As there is no blast nozzle an air draft through ventilators is used for maintaining the required action on the fire, in conjunction with a blower. It is claimed that while making the trial trips the engine has shown a fuel economy 25 per cent under that of the compound locomotives in service, while it runs very smoothly at high speeds, this being accounted for by the reduction of the reciprocating parts. The special equipment was designed by Mr. Zoelly, of Escher Wyss and Company, Zurich, and applied to the locomotive at the Swiss Locomotive Works at Winterthur.

Rankine the Man

Back of the editor's desk in the editorial rooms of MECHANICAL ENGINEERING hangs a finely executed portrait of Prof. William J. M. Rankine, whose textbooks on the steam engine and applied mechanics have thrown consternation into the hearts of many aspirants to the degree of M.E. in our technical schools, but who in after years have blessed the days of rigorous training prescribed by this master of engineering mathematics.

It may relieve the minds of some to learn what apparently is not well known, that Rankine was not only a profound technologist who delighted in disciplining the youthful mind, but he also was a humorist and a many-sided man.

A short time ago Mr. Frank E. Law, former chairman of the Finance Committee of the A.S.M.E., sat under the above-mentioned portrait in the editorial rooms and recited a humorous poem entitled The Mathematician in Love. Rankine's eyes appeared to twinkle, whereupon Mr. Law said that no other than Rankine himself had written it, and many more just as good.

Since then a letter received from Mr. Law gives the following interesting bits of information:

> Referring to our conversation today, the article on Rankine in the Encyclopaedia Britannica, Eleventh Edition, Vol. XXII, page 894, says,—after referring to Rankine's contributions to technical journals and to his textbooks—"These writings, however, corresponded to but one phase of Rankine's energy and many-sided character. He was an enthusiastic and most useful leader of the volunteer movement from its beginning, and a writer, composer and singer of humorous and patriotic songs, some of which, as 'The Three Foot Rule' and 'They Never shall have Gibraltar,' became well known far beyond the circle of his acquaintance."
>
> I think you would do a real service in calling attention to this human quality in Rankine. Most think of him only as a dry-as-dust writer.
>
> The Encyclopaedia article speaks of Rankine's Scientific Papers, published in London, 1881, and says the volume contains a memoir of Rankine by Prof. P. G. Tait. This memoir would doubtless supply many interesting details.

Industrial Disputes in Canada

The establishment of the industrial courts in Kansas less than a year ago has brought very forcibly to public notice the part the Government plays in the maintenance of operation of essential industry. Canada recognized the need for action and in 1907 Parliament enacted the Industrial Disputes Investigation Act for aid in the prevention and settlement of strikes and lockouts. This act, commonly known as the Lemieux Law, has been amended from time to time and as at present in force may be briefly outlined as follows:

Wherever a dispute arises between the employer and any of his employees, either of the parties may apply to the Minister of Labor for the appointment of a Board of Conciliation and Investigation consisting of three members appointed by the Minister. One of these shall be appointed on the recommendation of the employer, one on the recommendation of the employees, and the third on the recommendation of the members previously chosen. The Board holds office until its final report is placed in the hands of the Minister of Labor. The Minister is given discretion in the granting of an application for the appointment of a board, but after being appointed no court proceedings may be held to question the establishment of a board or its proceedings. The Board is charged with careful inquiry into the dispute and all matters affecting its merits and right settlement. It is given latitude in making suggestions that will induce the parties to the dispute to come to a fair and amicable settlement, and if a settlement is reached it is as binding as any recommendation of the Board. In case the Board cannot settle the dispute, a full report is made to the Labor Minister setting forth the evidence and making recommendation for its settlement according to the merits and substantial justice of the case. The Board is empowered to force the attendance of witnesses and administer oaths and it can require that books, papers and documents be produced for its investigation. Fines are prescribed for persons guilty of contempt of the Board. The proceedings of the Board may be conducted in public at its discretion, and if necessary it may employ experts to advise on technical matters. The members of the Board are paid at a per diem rate plus actual traveling expenses.

Strikes and lockouts prior to and pending the reference of dispute to the Board of Conciliation and Investigation are declared illegal, and both employer and employees must give at least thirty days' notice of any intended change affecting conditions of employment with respect to wages or hours. Penalties are provided for strikes and lockouts contrary to the provisions of this law. In some cases where the Minister of Labor discovers that a strike or lockout is imminent he may initiate action in the formation of a Board without application from any interested party. Some special treatment is authorized in case railroads or municipalities are parties to a dispute.

The Lemieux Law as outlined does not prohibit strikes or lockouts, merely insuring their consideration by an arbitration body.

The formation of the Board will tend to bring the parties in

the case together, and even though a settlement is not reached, the application of the recommendation by the Board will be a firm step in the stabilization of the industry.

What may be accomplished by such arbitration as that conducted under the Lemieux Law is shown by the following figures:

Out of 323 disputes affecting mines, transportation, public utilities and war work referred under the Act from the time of its enactment until March 31, 1919, 300 were settled by arbitration, only 23 strikes taking place. From April 1, 1918, to March 31, 1919, there were only two strikes out of 75 disputes. Equally encouraging figures are given for 1920. On December 31, 1920, there were on record but four strikes, affecting 379 people. The Lemieux Law is proving itself to be a most effective means for establishing industrial peace.

News of Other Societies

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Meeting at Akron and Cleveland, January 14. Sub-Committee on the Rubber Industry, of the Industrial and Domestic Power Committee, presented paper on Application of Electric Power in the Rubber Industry. A report of the committee on coördination of institute activities included a recommendation that the policy be established of awarding prizes for the most worthy papers presented before the institute. The board of directors approved the recommendation in principle and referred the matter back to the committee for the purpose of formulating a plan of procedure.

SOCIETY OF AUTOMOTIVE ENGINEERS

Meeting in New York, January—during the automobile show. At a session devoted to fuels, ways and means were discussed for improving the automobile engine so as to make the fuel supply last longer. Abstracts of five of the papers presented at this session are given in the Survey Section in this issue. An aviation session was held at which difference of opinion developed as to the advisability of using large, multi-motored planes, or smaller planes with single motors. It was subsequently agreed that the design of the plane depends entirely on the service required as to distance, loads and the character of the country over which the flight is made. Among the aviation papers were: Propellers, by F. W. Caldwell; Design Requirements of Commercial Aviation, by Grover C. Loening; Airplane Wings, by C. D. Hanscom; Commercial Aviation, by Glenn L. Martin; and Compression Pressures and Engine Performance, by S. W. Sparrow.

AMERICAN SOCIETY OF CIVIL ENGINEERS

Annual Meeting in New York, January 19 and 20. Attention was chiefly centered in the election of officers as follows: George S. Webster, Philadelphia, president; Andrew M. Hunt, New York, and Edward E. Wall, St. Louis, Mo., vice-presidents; and O. E. Hovey, New York, treasurer. The committee on stresses in track supplemented its elaborate report of last year by giving details of tests and experiments conducted to demonstrate the effect of curves on the stress in the rail, and the action on the track of flat spots in wheels. Other special committees also presented reports. It was determined that the board of direction should act as a committee to decide on matters affecting the relations of the society with other technical organizations. Under this arrangement the board will keep in touch with the Federated American Engineering Societies and other organizations, and in this way with general activities of interest to engineers.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Annual meeting in Philadelphia, January 26, 27 and 28. Reports were presented by the society's respective committees on code for testing low-pressure heating boilers, on standard code for testing heating systems, on steam and return main sizes, on schoolhouse standards, on standard method for testing air washers, on furnace heating, and on research. A paper by A. B. Reck, of Copenhagen, Denmark, on the influence upon boiler economy of continuous firing with highly volatile fuel without intervening cleaning, is abstracted in the Survey Section in this issue. A theory of dust action developed from investigations carried out jointly by the research bureau of the society and the United States Bureau of Mines, was presented by O. W. Armspach. An abstract of this paper was published in the Survey Section of MECHANICAL ENGINEERING for February, p. 130. Other technical papers of mechanical engineering interest were: Design of Large Boiler Plants, by J. Grady Rollow; Method of Utilizing Heating Systems for Cooling Rooms in Summer, by A. M. Feldman; Forced Hot-Water Circulation Heating System, by Robert Hughes; Accelerated Hot-Water Systems, by A. J. Wells; Pulverized Coal for Power Plants, by F. A. Scheffler; Briquetted Coal for Household Fuel, by I. H. Kennedy; Economizers, by W. F. Wurster; Transmission of Heat through Single-Frame Double Windows, by A. N. Shaw; and Comparative Tests of Sixteen-Inch Roof Ventilators, by Dryden, Stutz and Heald, of the U. S. Bureau of Standards.

PROVIDENCE ENGINEERS CONSIDER TRANSPORTATION

"One of the most important problems in the industrial life of New England is that of efficiently supplying raw material and distributing the finished product. The future prosperity of the country is dependent to a large extent on the ability of the railroads to meet out transportation requirements."

The above words were in the rallying call of the Providence Engineering Society to its Fifth Annual Banquet held February 1, 1921. In addition to addresses by the governor of the state and the mayor of Providence, Prof. William J. Cunningham spoke concerning the Federal Control of Railroads. Professor Cunningham is the James J. Hill Professor of Transportation at Harvard University and has had nearly twenty-five years of practical railroad experience in the traffic, operating and executive departments of various railroads throughout the United States. He pointed out that railway rates could not be increased beyond the point where they would tend to drive traffic away. He criticised the standard of wage rates established throughout the country by the Railroad Administration, and emphasized the fact that increased revenue, increased rates and further operating economies were necessary to make the roads self-supporting. He also decried as a national calamity the public ownership of railroads.

Arthur P. Russell, vice-president of the New York, New Haven & Hartford Railroad, outlined the financial difficulties of the New England railroads and took up the situation of the New Haven road in some detail. In the matter of railroad development he paid specific attention to the problems in Providence and told of plans for increased efficiency that will be derived from improved facilities in the Providence district.

John Fritz Medal for 1921 Awarded to Sir Robert A. Hadfield

At the annual meeting of the John Fritz Medal Board of Award held on January 21, 1921, the John Fritz Medal for 1921 was awarded to Sir Robert A. Hadfield, of London, for the invention of manganese steel. Manganese steel was first described in a paper read by Sir Robert before the International Engineering Congress in 1893. For uses in which toughness combined with great strength is demanded, manganese steel is invaluable. It is non-magnetic and its applications have been many and varied. During the war 9,000,000 Hadfield manganese-steel helmets were used by the English, American and Belgian armies, and at the close of the war the Hadfield helmets were rapidly replacing the French type.

Sir Robert A. Hadfield is one of the leading steel manufacturers of England and was the first to introduce the 48-hour week in his work, putting it into effect 25 years ago. During the war he was one of the largest producers of munitions for the British Navy. Besides manganese steel he invented a magnetic steel of high permeability, especially suitable for use in dynamos and motors; showed that steel containing a small percentage of silicon, after a double heat treatment, was far superior to the purest obtainable iron; and is responsible for other important developments in the steel industry. He has been a prolific technical writer and an energetic promoter of the scientific societies of Great Britain. He is a member of the American Institute of Mining and Metallurgical Engineers and The American Society of Mechanical Engineers, and is one of the greatest users by mail of the Engineering Societies Library.

Marine Electrical Engineering

Discussion of Use of Electricity in Marine Work at Joint Meeting of New York Sections of Electrical and Mechanical Engineers

THE immense tonnage of the American Merchant Marine presents engineering problems of great import. To consider the use of electricity in marine work, the third of the joint meetings of the New York Section of the American Institute of Electrical Engineers and the Metropolitan Section of The American Society of Mechanical Engineers brought together a large, deeply interested audience in the Auditorium of the Engineering Societies Building on the evening of January 28, 1921.

The program of the evening was in charge of Alfred E. Waller, of the Marine Committee of the A.I.E.E. and chief engineer of the Ward Leonard Company.

Admiral W. S. Benson, chairman of the United States Shipping Board, outlined the steps necessary in the development of the American Merchant Marine and emphasized the present slow development of electric power and its application in our naval vessels. He stressed the necessity of meeting foreign competition in the cost of operation of ships. The principal problem in operation is one of fuel, and Admiral Benson insisted on oil rather than a return to the use of coal. He bespoke especially the development of an efficient internal-combustion engine for marine work.

H. L. Hibbard, of the Cutler-Hammer Manufacturing Company, presented a paper on Electricity Applied to Ship Auxiliaries. He outlined the development of the past four or five years and described the design requirements of auxiliaries, emphasizing the specific needs for ventilated and enclosed watertight motors. The various types of control for auxiliaries were also listed and the peculiar characteristics of motors for driving, engine-room auxiliaries, deck machinery and steering gear were treated in some detail. Concerning definite advantages of auxiliaries electrically driven, Mr. Hibbard said:

> It has been shown by experience that the electric drive of the auxiliary machinery has resulted in a considerable saving in fuel consumption of a vessel. This applies particularly to vessels using steam for their main propulsion. For ships operated by Diesel engines or Diesel-electric drive it is obviously of great advantage to operate all the engine-room auxiliaries by electricity, as it is largely a question of the efficiency of electric transmission with a large and reliable generating unit against a number of small inefficient oil or steam engines, and it is naturally desired to avoid the generation of steam in any quantity on a motorship.
>
> In the matter of first cost, it is also apparent from such figures as have been available to date that electrical auxiliary machinery is roughly about 20 per cent more expensive than steam, except in case of deck winches where the difference is more, sometimes 100 per cent. It is also found that an oil-engine-propelled motorship is about 30 per cent more expensive in first cost than a steam-driven vessel and that, strange as it may seem, the Diesel-electric-propelled ship is slightly less expensive than the straight Diesel owing to the smaller and higher-speed oil engines which it is possible to utilize.
>
> As against these disadvantages of first cost and weight, are obtained the advantages of:
>
> 1 Suppression of heat in spaces adjacent to the gear and transmitting lines, which is of importance in certain cases
> 2 Elimination of accidents due to freezing and bursting of steam pipes, cylinders, etc.
> 3 Reduction of vibration and noise and an increase in the habitability of the ships due to these factors. This is particularly marked in the case of the steering gear
> 4 Simplification and flexibility of control, operation being obtained readily from the most convenient point
> 5 The obtaining of mechanisms as outlined above which are very much more efficient in operation than the steam equipments. This is the most important consideration.
>
> Another important consideration is the fact that experience shows on motorships already constructed with electrical auxiliaries, that in port the power required during the period that the deck winches are handling the cargo is about three times the amount required with the auxiliaries at sea.

Commander C. S. McDowell, U. S. N., emphasized the need of proper terminals for proper shipping and the necessity for electrifying terminals, giving in detail suggestions as to the electrically operated devices that might be used in terminal operation.

Under the subject of Turbine Reduction Gears versus Electric Propulsion for Ships, Eskil Berg, of the General Electric Company, treated various types of ships and discussed the relative merits of the two types of drives in each case. The following is a résumé of his paper:

> The Navy Department, after years of comparative study and having actual operating data on electrically propelled vessels available, has decided to equip all the larger Navy vessels with electric drive. Economical cruising speed can be obtained, machinery can be located in invulnerable places, plurality of generating units can be used, and maneuvering can be accomplished more quickly and accurately.
>
> Geared turbine drive has an advantage in fast destroyers and light cruisers, where the power is large and the propeller speed high. The weight of propelling machinery in this type of vessel is of utmost importance and electric drive, being heavier, cannot be considered.
>
> In merchant ships each individual case must be studied, considering the questions of service, economy, reliability, weight and cost. For fast passenger liners electric drive has an advantage, for transmission efficiency can be made practically equal to double-reduction gearing and a more efficient turbine can be built. Noise is practically eliminated with electric drive.
>
> In moderate-power twin-screw ships of 6000 to 8000 hp., electric drive has a decided advantage both in economy, weight and price if one turbo-generating unit is used to drive both propellers.
>
> In slow-speed single-screw freighters of 2500 to 3000 hp., the geared turbine is somewhat lighter. The actual transmission efficiency of the gears is also better. Considering losses of the reversing turbine, packing losses, and leakage of steam due to larger clearances, the transmission efficiency is in favor of electric drive. If, however, the motor is located aft, doing away with long shafting with its expensive bearings, supports and shaft alleys, the electric drive is the lightest, cheapest and most economical, as well as the most reliable method to use.
>
> In freighters of 1500 hp. or less, geared turbines are lighter and cheaper. As the power is small, a gear can be designed which is less affected by sudden load variation or disalignment caused by springing of the hull or inaccurate workmanship.

In his paper on the Electric Propulsion of Ships, W. E. Thau, of the Westinghouse Electric and Manufacturing Company, discussed various types of power drives and described the installation of the propelling machinery on the U. S. S. *Tennessee*.

In discussing Commander McDowell's paper, R. H. MacLain, of the General Electric Company, stressed the necessity for structural changes in boats to permit more rapid stowing and breaking down of cargo, pointing out that the solution of the freight-handling problem on the Great Lakes was derived from the construction of the boats themselves.

G. A. Pierce, of The William Cramp & Sons Ship and Engine Building Company, in discussing Mr. Berg's paper, pointed out the advantages of the reciprocating engine in naval and coastwise ships. He further emphasized reliability, simplicity and ease of operation as points to be considered in a discussion of the relative merits of mechanical reduction-gear drive versus electric drive.

In a discussion of Mr. Thau's paper Commander Jones of the U. S. S. *Tennessee* testified that the records of the ships now in service show that electric-drive propulsion has established itself, and stated that operating personnel can be successfully trained in a comparatively short time to handle casualties to machinery and apparatus with as much facility as with the older types of propulsion.

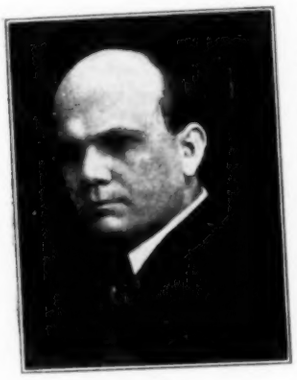
Engineering Foundation Endowment

The Engineering Foundation, established in 1914 for the stimulation and support of research in science and engineering, is frequently obliged to refuse to support research projects brought to it because it lacks funds. The Foundation needs a large increase of endowment. Nine donations of $50,000 each are desired so that an offer of $50,000 toward a half-million may be claimed. Gifts to the Foundation are exempt from income tax and each donor of $250,000 or more will be honored as a Founder.

The Foundation is administered under the auspices of the United Engineering Society, American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers and American Institute of Electrical Engineers, by the Engineering Foundation Board, consisting of thirteen representatives of these societies, and three members at large. Alfred D. Flinn, 29 West 39th Street, New York, N. Y., is Secretary and further information may be secured from him.

L. W. Wallace Secretary of F.A.E.S.

American Engineering Council in Session at Syracuse, February 14, Elects Executive Secretary of the New Organization—Herbert Hoover Gives Address on Industrial Waste



L. W. Wallace

THE American Engineering Council met at the Hotel Onondaga, Syracuse, N. Y., morning and afternoon, on February 14, for the transaction of business matters relating to the work of The Federated American Engineering Societies. The Council strongly endorsed the model bill on registration of engineers previously prepared by Engineering Council and reported in MECHANICAL ENGINEERING for December 1920, p. 717. It also approved legislation proposed in connection with the Nolan Patent Bill providing for a reciprocal arrangement with foreign countries to remove discrimination against patents in foreign countries held by American inventors. Announcement was made of the membership of the Federation's Committee on Elimination of Waste in Industry, appointed in accordance with the suggestion of Herbert Hoover that the subject be taken up as one of the major activities of the Federation. The personnel of the Committee is as follows: J. Parke Channing, Chairman; L. W. Wallace, Vice-Chairman; Robert B. Wolf, Chas. E. Knoeppel, Robert Linton, J. H. Williams, Fred. J. Miller, L. P. Alford, Ira N. Hollis, George D. Babcock, Morris L. Cooke, E. E. Hunt, Harrington Emerson, H. R. V. Scheel, and F. G. Coburn. It was voted to recommend to President-Elect Harding that an engineer be appointed on the Interstate Commerce Commission. Before adjournment the next place of meeting of the Council was announced to be Philadelphia.

The most important action at the meeting was the election of L. W. Wallace as secretary of The Federated American Engineering Societies. Mr. Wallace has already been serving as treasurer of the Federation and as vice-chairman of its Committee on Industrial Waste. In view of his election as secretary the position of treasurer became vacant and W. W. Varney of Baltimore was elected temporary treasurer.

Mr. Wallace was graduated in mechanical engineering from the Agricultural and Mechanical College of Texas in 1903. He afterward served a railroad apprenticeship and became instructor at Purdue University, then assistant professor of car and locomotive design, and finally, in 1913, head of the department of railway and industrial management, which position he held until 1917. He received the degree of M.E. from Purdue in 1912. Upon leaving the university he became assistant general manager of the Diamond Chain and Manufacturing Company, Indianapolis, Ind. At the close of the war, when the Red Cross Institute was established at Baltimore for the purpose of giving vocational training to blind soldiers, Mr. Wallace left Indianapolis to become director of the Institute and conducted the work until last January, when he was elected treasurer of The Federated American Engineering Societies.

In the conduct of his many activities he had displayed breadth of vision and has been actuated by altruistic motives, characteristics which, combined with an executive experience and a deep interest in the principles of management, admirably adapt him for the work he is to undertake. In various addresses on the subject of industrial management before The American Society of Mechanical Engineers and elsewhere he has shown insight into the fundamentals underlying industrial unrest and a sympathetic appreciation of the rights as well as the responsibilities of employee and employer. This latter will be a most favorable asset to Mr. Wallace in conducting the important investigation dealing with the elimination of waste in industry which is to be undertaken by the Federation.

Address on Industrial Waste by Herbert Hoover

In addressing the American Engineering Council of the F.A.E.S., Mr. Hoover said the Federation is in a position of disinterested service and wants nothing from the public, either individually or as a group. It has initiated services to the public in many directions. One of these is the preliminary survey of some of the weaknesses in our production system, recently organized by the Council. Mr. Hoover directed his attention mainly to an outline of these weaknesses, with suggestions of ways and means for increasing production and improving industrial relations. In concluding he said, "We do not believe it is necessary to effect those things by the Government. The spirit of coöperation that has been growing in our country during the last thirty years has already solved many things; it has standardized some things and is ripe for initiative toward coöperation of a widespread character. The leadership of our Federal Government is bringing together the forces as needed. No greater field of service exists than the stimulation of such coöperation. The first step is sane analysis of weakness and sober proposal of remedy. If the facts can be established to an intelligent people such as ours, action is certain even if it be slow. Our engineers are in unique position for this service, and it is your obligation to carry it forward."

An abstract of Mr. Hoover's summary of the most important elements in industrial waste is given below:

The waste in our production is measured by the unemployment, the lost time due to labor conflict, the losses in labor turnover, the failure to secure maximum production of the individual due either to misfit or lack of interest. Beyond this again is a wide area of waste in the poor coördination of great industries, the failures in transportation, coal and power supplies which reccho daily to interrupt the steady operation of industry. There are again such other wastes due to lack of standardization, to speculation, to mismanagement, to inefficient national equipment and a hundred other causes. There is a certain proof of deficient production by comparisons of our intense results in 1918, when, with 20 per cent of our man power withdrawn into the army, we yet produced 20 per cent more commodities than we are doing today. We are probably not producing more than 60 or 70 per cent of our capacity.

No one will ever suppose that it is ever possible to bring national productivity up to the full 100 per cent, but the whole basis of national progress, of an increased standard of living, of better human relations, indeed, of the advancement of civilization, depends upon the continuous improvement in productivity. While we currently assume that great advances in living standards are brought about by new and basic inventions, yet in fact even a greater field of increasing standard lies in the steady elimination of these wastes. The primary duty of organized society is to enlarge the lives and increase the standards of living of all the people—not of any special class whatever. We are therefore proposing to make a preliminary examination of the volume of waste in certain industries, the proportions that lie in each field of fault. And no engineering report is worth the paper it is written upon without constructive suggestions in remedy.

There is ofttimes a superficial dismissal of this subject of maximum production on the assumption that there are positive limits in production due to oversupply. Such assumption has no proper foundation in the broad view of industry as a whole. Too much economic thought on production has delimited its boundaries by the immediated volume of demand of a given commodity. There is no such thing as the nation overproducing, if it produces the right commodities. The commodities or services produced by the whole nation are capable of absorption by the whole nation if they are of the right character. When ten men or one hundred million men divide their united output, they can by doubling their output have twice the amount to divide. The problem in doubling output is to direct it to commodities or services that they can use. There is no limit to the increase of living standards except the limitations of human strain, scientific discovery, mechanical invention and natural resources.

It is true enough that any particular commodity or service can be overproduced, for each will reach a saturation point in demand when all the members of the community have been supplied. The absorption of increased productivity lies in the conversion of luxuries of today into necessities of tomorrow, and to spread these through the whole population by stimulation of habit and education. Wheat bread, railways, good roads, electricity, telephones, telegraphs, automobiles and movies were once luxuries. They are still luxuries to some parts of the population.

It is but a corollary that certain commodities can better be produced for exchange for commodities from outside our boundaries of more appro-

(Continued on page 219)

Engineering and Industrial Standardization

Standardization of Elevators

IN the December 1920 issue of MECHANICAL ENGINEERING an announcement was made of the calling of a conference on the Standardization of Elevators. As a result of this conference the American Institute of Architects, The American Institute of Electrical Engineers and The American Society of Mechanical Engineers were invited by the American Engineering Standards Committee to act as joint sponsor for this standardization project.

These societies have accepted this sponsorship and have formed the Sectional Committee which held its organization meeting on February 15. The members of this committee and the organization which they represent are listed below:

S. F. VOORHEES and R. H. Shreve, American Institute of Architects
W. W. CHAPIN and PAUL M. LINCOLN, American Institute of Electrical Engineers
W. S. ATKINSON, and (to be appointed) The American Society of Mechanical Engineers
B. JONES, joint appointee of three Sponsors
I. N. HAUGHTON, N. O. LINDSTROM, C. REEDY, H. F. GURNEY and H. A. PRATT, Elevator Manufacturers Association of New York
R. P. MILLER, American Institute of Consulting Engineers
S. F. HOLTZMAN, American Society of Civil Engineers
D. E. LINDQUIST, American Society of Safety Engineers
H. L. WHITTEMORE, Bureau of Standards, Department of Commerce
R. D. SPALDING, Bureau of Yards and Docks, Navy Department
CAPT. A. B. FRY, Office of Supervising Architect, Treasury Department
T. E. BARNUM and W. H. PATTERSON, Electric Power Club
W. W. LIGHTHIPE and, National Association of Building Owners and Managers
C. M. HANSEN, National Association of Manufacturers
R. P. MILLER, Building Officials' Conference.

Specifications and Codes Submitted to American Engineering Standards Committee for Approval

Three A.S.T.M. Specifications. The American Society for Testing Materials has submitted the following specifications to the American Engineering Standards Committee for approval as Tentative American Standards:

Standard Test for Toughness of Rock
Standard Method for Distillation of Bituminous Materials Suitable for Road Treatment
Standard Method for Sampling Coal.

These specifications may be found in the 1918 volume of A.S.T.M. Standards. Copies may also be obtained from the American Engineering Standards Committee, 29 West 39th Street, New York City.

National Electrical Code. The National Fire Protection Association has submitted its Regulations of the National Board of Fire Underwriters for Electric Wiring and Apparatus, edition of 1920, frequently referred to as the National Electric Code, to the American Engineering Standards Committee for approval as an American Standard. Copies of the Code may be obtained from the National Board of Fire Underwriters, 76 William Street, New York, or from the American Engineering Standards Committee, 29 West 39th Street, New York.

Mining Specifications. The Bureau of Mines has brought three of its publications to the attention of the American Engineering Standards Committee for consideration as Tentative American Standards. They are:

Permissible Portable Electric Mine Lamps (Schedule 6A)
Specification for Storage-Battery Locomotives (Schedule 15)
Suggested Safety Rules for Installing and Using Electric Equipment in Bituminous Coal Mines (Technical Paper 138)

Copies of these specifications may be obtained from the Bureau of Mines, Washington, D. C., or from the American Engineering Standards Committee, 29 West 39th Street, New York.

These specifications and codes are submitted for consideration in accordance with the special provision in the procedure of the Committee, under which important specifications in existence prior to 1920 may be approved without going through the regular process followed in new work. The Committee would be very glad to learn from those interested of the extent to which they make use of these specifications and rules, and to receive any other information regarding them in meeting the needs of the industry.

Cement Specifications. Complete agreement has been reached on specifications and tests for portland cement, so there is now one specification covering both commercial and governmental use. The revised specifications, which were agreed upon by Committee C-1 of the American Society for Testing Materials and the Government Departmental Committee on Cement, have also received the approval of the American Engineering Standards Committee. Copies may be obtained from this committee or from the American Society for Testing Materials.

Recent Foreign Engineering Standards

Copies of the following engineering standards, issued in 1920 by foreign national standardizing bodies, are on file with the American Engineering Standards Committee:

British Engineering Standards Association:
No. 1 Rolled Steel Sections for Structural Purposes, Lists of
No. 12 Portland Cement, Specification for
No. 94 Watertight Glands for Electric Cables, Specification for
No. 97 Watertight Fittings for Incandescent Electric Lamps, Specification for
No. 100 Body Spaces and Frame Ends for Chassis for Private Automobiles, Dimensions for
No. 106 Electrically Heated Cooking Range, Specification for
No. 122 Milling Cutters and Reamers, Standards for
No. 131 Notched Bar Test Pieces, Forms of

Canadian Engineering Standards Association:
No. 1 Steel Railway Bridges, Standard Specification for

Association Belge de Standardisation (Belgium):
No. 1 Construction of Metal Framework, Rules for
No. 2 Construction of Metal Tanks, Rules for
No. 3 Construction of Coverings and Partitions of Corrugated Galvanized Sheet Iron, Rules for
No. 4 Shafts and Transmission Pulleys, Standardization of
No. 5 Construction of Metal Bridges, Rules for.

Hoofdcommissie voor de Normalisatie in Nederland (Holland):
N–19 Compression Couplings
N–20 Flange Couplings
N–29 Loose Collars for General Construction
N–30 Loose Collars for Mill Gearing.

Normenausschuss der Deutschen Industrie (Germany):
DIN–187 Angle Arm for Fixed Bearings for Transmission Shafting
DIN–475 Widths of Spanner Jaws.

Commission de Normalisation du VSM (Switzerland):
VSM–10300 to VSM–10307 Technical Drawings—Oblique Script; Size of Letters; Graphic Presentation of Screw; Cross-Sections
VSM–12050 Whitworth Screw Threads; General Data
VSM–33900 to VSM–33914 "Sulzer" Attachment for Milling Cutters

Sveriges Maskinindustriförening (Sweden):
SMS–1 Size for Standard Sheet
SMS–2 Metric Screw-Thread System
SMS–3 Whitworth Screw-Thread System
SMS–5 Hexagonal Nuts—Type B6M–BSW Screw-Thread System
SMS–7 Finished Hexagonal Screws—Type B6S–BSW Screw-Thread System
SMS–8 Series of Standard Diameters.

Photostatic copies of these standards can be furnished at a nominal cost, or the copies on file may be consulted at the offices of the American Engineering Standards Committee, 29 West 39th Street, New York.

Standardization of Wires and Cables

At a recent conference called by the American Engineering Standards Committee at the instance of the American Railway Engineering Association and attended by representatives of 14 national organizations, it was unanimously decided that the unification of specifications for wires and cables for other than telephone and telegraph use should be undertaken under one general plan, covering substantially all the more important uses. The proposed work, it is stated, will be carried out under the auspices and rules of procedure of the American Engineering Standards Committee.

Library Notes and Book Reviews

AEROPLANE STRUCTURAL DESIGN; a book for designers, draughtsmen and students. By T. H. Jones and J. D. Frier. Sir Isaac Pitman & Sons, Ltd., New York, 1920. Cloth, 6 × 8 in., 267 pp., plates, tables, charts, diagrams, $7.50.

Although several valuable treatises exist dealing with the problems of sustentation, stability and aerodynamics generally, the authors feel a need for a book treating the structural strength of the aeroplane, in which the loading of it and the methods of estimating its strength under load are discussed definitely and practically. The present volume treats in detail of the wings, fuselage, tail plane and elevators, landing gear and rear skid, control surfaces, flying controls and details, and is equipped with numerous tables of data needed by the designer. Complicated mathematical discussions are avoided.

AUTOMOTIVE IGNITION SYSTEMS. By Earl I. Consoliver and Grover I. Mitchell. First edition. McGraw-Hill Book Company, Inc., New York, 1920. (Engineering education series.) Cloth, 6 × 9 in., 279 pp., illus., diagrams, $2.50.

This is a systematic course of study of the ignition systems used on automobiles, tractors and airplanes, for those who have to install, adjust and repair these systems in the factory and repair shop.

CONCRETE WORK. By William Kendrick Hatt and Walter C. Voss. Vol. 1, N. Y., John Wiley & Sons, Inc.; Lond., Chapman & Hall, Ltd., 1921. 451 pp., illus., diagrams, tables, 8 × 6 in., cloth, $4.00.

This is the first part of a two-volume manual intended to extend the scope of work now possible to the concrete worker of unguided experience by bringing him to an intelligent understanding of the scientific principles underlying his art, and by introducing him to the wider opportunities that exist for him in modern construction. The method used to present the subject is based upon the experience acquired by the Committee on Education and Special Training of the War Department, in training 130,000 soldiers in the various trades connected with military operations. The present volume of the manual contains the development of principles and information on methods of construction and standards necessary for the construction of the definite building.

CONTRACTS IN ENGINEERING. By James Irwin Tucker. Second edition, seventh thousand. McGraw-Hill Book Co., New York, 1920. Cloth, 6 × 9 in., 331 pp., $4.

This book is intended as a practical course showing the contractual basis of engineering work and of business at large, and as a textbook for engineering students with no opportunity for extended study of legal principles. It aims to present those facts and rules that seem likely to be of most value to an engineer in his professional and business career and to give him substantial information upon many legal matters.

DRANG UND ZWANG; EINE HÖHERE FESTIGKEITSLEHRE FUR INGENIEURE. Von Aug. Föppl und Ludwig Föppl. R. Oldenbourg, München und Berlin, 1920. Paper. 2 vols. 7 × 70 in., 72 Marks.

The authors of these volumes discuss some of the more abstruse problems of stress and strain. The work is intended especially for engineers who are fitted, by practical experience, to follow a difficult investigation and apply its results. A knowledge of the elementary theory of the mechanics of materials is expected of the reader.

EXPORTER'S GAZETTEER OF FOREIGN MARKETS, 1920–21. Compiled and edited by Lloyd R. Morris. The American Exporter, New York. Cloth, 6 × 9 in., 789 pp., maps, tables, $10.

This gazetteer is planned to present concisely facts about markets which have heretofore been obtainable only in scattered primary sources. The information includes the area and population of each country, the population of its principal towns, its commerce, production and industry, telegraphs, telephones and railroads, money, weights and measures, commercial language, principal shipping routes, customs tariff, consular regulations and representation, and similar matters. Maps of the principal countries are included. Foreign currencies and measurements have been converted into American equivalents.

FACTORY ORGANIZATION AND ADMINISTRATION. By Hugo Diemer. Third edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 413 pp., illus, $4.

This book is for officers of manufacturing corporations, works managers, superintendents, accountants, and those in charge of such activities as purchasing, stores, costs and production. The present edition has been revised to conform with the evolution of practice and standards, particularly in relation to organization, personnel problems and the functional control of production. An extensive bibliography is included.

THE GASOLINE AUTOMOBILE; ITS DESIGN AND CONSTRUCTION. Vol. 1, The Gasoline Motor. By P. M. Heldt. Sixth edition. P. M. Heldt, Nyack, N. Y., 1920. Cloth, 6 × 9 in., 639 pp., illus., diagrams, charts, $6.

Continued development of the internal-combustion engine has made necessary a further revision of this volume. The chapters on the cylinder, crankcase and oiling system have been rewritten, and that on the piston, piston rings and piston pin revised to accord with modern practice. New material on other subjects has been added in an appendix and a number of new plates have been included.

HEAT ENGINES; A TEXT-BOOK FOR ENGINEERING STUDENTS. By David Allen Low. Longmans, Green and Co., New York, 1920. Cloth, 6 × 9 in., 597 pp., illus., diagrams, charts, tables, $6.50.

The author has attempted to compress into one volume of moderate dimensions sufficient material for a two-years' course in the subject, in which its theoretical and practical sides would be combined. Numerous exercises for the student are included, most of which are original.

THE MAKING OF HERBERT HOOVER. By Rose Wilder Lane. The Century Co., New York, 1920. Cloth, 5 × 8 in., 362 pp., portraits, $2.50.

Upon the foundation of documents, letters and diaries, and information supplied by Charles K. Field, a friend and college classmate of Mr. Hoover, Mrs. Lane has prepared an informal, readable account of his life. The book is unusual in method, but achieves success as an interpretation of the man.

TANKS IN THE GREAT WAR, 1914–1918. By J. F. C. Fuller. E. P. Dutton and Company, New York, 1920. Cloth, 6 × 9 in., 345 pp., frontispiece, maps, plates, $9.

This volume, by a former Chief General Staff Officer of the Tank Corps of the British Army, is a readable account of the genesis of the tank and of the part played by it in the Great War. The work of the French, German and American tank corps is covered also.

Address on Industrial Waste by Herbert Hoover

(Continued from page 217)

priate character to our needs. Today we have capacity for production of some commodities not only in excess of our home need, but even beyoad export demand under present financial conditions. As a matter of practical remedy, we must either reorganize these financial relations or alternately abandon some part of this kind of production and turn our idle men to making things of which we are not yet fully supplied.

The largest area of waste lies in the large periods of slack production and unemployment, due to the ebb and flow of economic tides between booms and slumps. The ideal would be steadily increasing production—an ideal of no likelihood of exact realization because of inability to ever gage in advance the growth in consumption or the approach of saturation. On the other hand, there are certain possibilities of stabilization worth consideration. Our studies of industries as a whole show that we usually expand our equipment just at the periods of maximum demand for their products instead of doing our plant expansion during periods of slack consumption. We thus make double demands on labor and we doubly increase unemployment in periods of reduced consumption. That is indeed one of the factors in our great unemployment today.

Everyone knows that for our normal productivity, our transportation facilities are today inadequate. We know that we are insufficiently housed, insufficiently equipped in our public roads and our public utilities; that we need an entire revision of our power supply, that we need expansion of our water ways; and yet armies of idle men are walking the streets.

The reasons why this occurs are not far to seek, in that it is at times of high productivity that capital is most easily obtained. It is then that the necessity of increased equipment most impresses men's minds and it is the high hopes of these periods that lead them into the adventure of expansion. Nor is it possible to expect that all industry can be so stabilized as to do its capital construction in periods of depression in commodity

demand. Nevertheless, there are some industries that could, by coöperation of the Government and coöperation among themselves, be led in this direction. More particularly does this apply to railways, telephones, telegraphs, power supplies and other public utilities, and to the expenditure upon our state, municipal and national public works.

Another variety of intermittent employment, and thus great waste, lies in certain industries now operating upon an unnecessarily wide seasonal fluctuation, as for instance the bituminous-coal industry. This is today one of our worst-functioning industries. These mines operate seasonally and erratically. They proceed from gluts to famines, from profiteering to bankruptcy. The mining engineers have already pointed out the direction in which the remedy lies, through storage, through railway rate differentials and other remedies. Through constructive action, an army of men could be released from this industry to convert some luxury into a necessity of tomorrow.

The second largest area of waste in productivity is the eternal amount of labor friction, strikes and lockouts. Fundamentally this is not alone a struggle for division of the results of production between capital and labor, but also in the element of purely human friction and loss outside the area of dispute on wages and hours. The growth of industry into large units has destroyed the old mutuality of interest between employee and employer. Our repetitive processes have tended to destroy the creative instinct and interest in employees; at times their efforts sink to low levels indeed. We will yet have to reorganize the whole employment relationship to find its solution. There is great promise in this field during the past two years, and the progress in this matter is one of the subjects under our inquiry.

Probably the next largest fraction of waste in productivity lies in a too high degree of individualism in certain basic products and tools. In other words, a standardization of certain national utensils makes for economy in distribution, in operation and in repairs. The necessity of maximum production during the war opened a great vista of possibilities in this direction. Such standardization as car couplings, or wheels, and cars generally, represents real progress in this direction. These possibilities lie in a hundred directions. There are all sorts of cases from sizes of chains to the size of automobile wheels. Today dozens of different sizes are placed in the market by manufacturers and entail not only special equipment and skill to produce these many varieties, but also great stocks are required in distribution and losses are entailed due to lack of interchangeability. Standardization does not mean that we stamp the individuality out of manufacture or invention or decoration; it means basic sizes to common and everyday things.

Another type of waste lies in our failure to advance our industrial equipment. The Super-Power Board will demonstrate the saving of 25,000,000 to 50,000,000 tons of coal annually by the electrification of our eastern power supply. The St. Lawrence Waterway Commission will demonstrate the saving of five to ten cents a bushel to the farmers of fifteen states by unlocking the lakes to ocean-going vessels.

Plans for Organizing Port of New York

(*Continued from page 211*)

railroads giving pier-station service; a joint yard and transfer station on this belt line; two parallel but independent tracks of standard gage in a loop in separate tunnels from the yard to Manhattan and back to the yard; a series of multiple-story terminals in Manhattan with car elevators to the surface from underground sidings; a fleet of special electrically operated cars and a fleet of special four-wheel trailer trucks. The tunnels will be far enough below surface so that rapid passenger transite development will not be hindered.

At the joint transfer station in New Jersey (see map) inbound freight will be transferred to trailer trucks, which will be borne by the electrically operated cars, mainly in a eight-car trains, to the Manhattan stations. The trains will be run at uniform rates of speed not exceeding 14 miles per hour, making it safe to move the trains at short intervals. At the stations the cars will be raised to the surface one at a time and their loads exchanged for trailers bearing outbound freight, after which they will be despatched in eight-car trains to the transfer station and unloaded into standard freight cars. The electric cars will move around the loop on either track in one direction only, each loop thus forming an independent line.

Figures prepared by the Commission show terminal costs of $1.82 per ton with this scheme as compared to $2.25 per ton with the present car float-pier station system and compared with $3.50 for standard-equipment elevated or underground systems.

The automatic-electric system is a radical device for port development, although it has been tried on a smaller scale by the London Post Office. The proposed scheme with its deep-laid tunnels has the advantage of being cheap to operate, is not affected by weather conditions, and removes trucking congestion in the already overcrowded streets of Manhattan.

CLOTHS FOR MECHANICAL USES

(*Continued from page 180*)

2 Machine leaders for:

Back filling	Drying	Shearing
Brushing	Felt hardening	Singeing
Calendering	Ironing	Sprinkling
Crabbing	Pressing	Starching
Dewing	Sanding	Water mangling

e Jackets. (Woolen):
Fulling-mill rolls
Gig rolls.

f Jute Cloth:
Aprons on take-up rolls — Leader on felt hardeners
Aprons on loom beams

g Laminated Cloth. (Cotton):

Check straps	Lug straps
Gears	Pickers
Harness straps	

h Printing. (Cotton, linen and wool):
See general head Printing

i Sheets. (Cotton or wool):
Extractor linings — Fulling-mill linings

j Steaming Blankets:
Wool

k Tapes and Webbing. (Cotton and asbestos):

Apperly feed bands	Harness straps	Slubbers
Can drier leaders	Mules	Spinning frames
Condensers	Machine belts	Spoolers
Doublers	Reducers	Twisters
Finishers	Roving frames	Winders

Asbestos. Asbestos cloth is such an unusual product, so unlike any other cloth that it is advisable to take it up separately. The two main fundamental differences in its use are, first, its heat- and flame-resisting qualities; and second, its neutrality to the actions of acids and alkalis. For these two reasons it can be used in places where no other fabric can. The cloth is usually of heavy yarns and a plain weave, varying in closeness of mesh and thickness as the purpose requires.

The great bulk of this cloth goes into steam packing. It is invaluable in this respect. In this is included gaskets and cut washers. The next largest amount goes into brake linings of all kinds, principally automobile. These may be entirely asbestos or wire warp with asbestos filling. Clutch facings come next in volume.

Filter cloths of various degrees of openness and thickness are used, mostly in chemical plants. Wire backings may be used in this work. This type of filter cloth is also used in making such gases as oxygen and hydrogen, and in such plants where refuse or sewerage has to be disposed of. The cloth is easily cleaned by subjecting to fire.

In the electrical industry asbestos cloth is used mostly in webbing or tape form in the manufacture of armatures, etc., and greatly in wire and cable manufacture. Tubing of this material is used also in cable manufacture and gives excellent protection.

For fire doors, heat screens, and curtains a heavy fabric is used, either plain or with a wire warp. Theater curtains are of this type. Iron and steel mills use this cloth around furnaces, etc. Light asbestos cloth is used to wrap asbestos or magnesia packing, but in general heavy cotton sheeting or light duck is best for this purpose.

The making of asbestos board, wall board, linings, shingles, etc., is practically dependent on a textile product, an endless woolen blanket a form of papermakers' felt. The sheet of asbestos is formed on this woolen blanket or felt, the stock being carried through press rolls and finally delivered in a formed but moist sheet to driers. This blanket is made of heavy woolen yarns about one-quarter to one-eighth run, twisted two, three or four strands together. It is a plain weave cloth, about six warps threads and six picks fulled heavily and lightly napped on one side to enable a new felt to easily start the stock. As to the exact workings of this endless woolen blanket or felt, see the paragraphs on Paper Industry, the principle being the same.

It will be found that in what has gone before there are a number of repetitions due to the unavoidable use of conflicting headings. The author by no means considers that every mechanical use is covered by the paper, but he does feel that it gives an idea of the tremendous use of cloth for mechanical uses and its importance in machine design, construction and operation.

THE ENGINEERING INDEX

(*Reg. U. S. Pat. Off.*)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with item dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents per page, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ABRASIVE WHEELS

100,000 r.p.m. Grinding-Wheel Spindle Operated at an Unusual Speed. Machy. (N. Y.), vol. 27, no. 5, Jan. 1921, p. 420, 2 figs. Spindle manufactured by A. A. Jones & Shipman Co., Ltd., Leicester, England, and designed to be operated at speed of 104,000 r.p.m. Drive is through intermediate shaft and special rubber belts are used. Spindle, which is in experimental stage, was shown at machine-tool exhibition recently held in London.

ACCIDENT PREVENTION

Foundry. Safe Shoes Reduce Hot-Metal Burns. Foundry, vol. 49, no. 2, Jan. 15, 1921, pp. 51–53, 5 figs. One-sixth of total foundry accidents are ascribed to defective and unsafe foot-wear. Foot injuries are reduced by proper shoes.

ACCIDENTS

Dust Explosions. A Dust Explosion During the Handling of Cottonseed Meal, David J. Price. Am. Fertilizer, vol. 54, No. 1, Jan. 1, 1921, pp. 53–57, 5 figs. Account of dust explosion which occurred during handling and elevating of cotton-seed meal.

Causes and Prevention of Dust Explosions. Colliery Guardian, vol. 120, no. 3128, Dec. 10, 1920, pp. 1677–1678, 1 fig. Account of German experiments. Translated from Zeitschrift fur Berg-, Hutten- und Salinenwesen.

Engineering Problems in Dust Explosion Prevention, David J. Price. Chem. & Metallurgical Eng., vol. 24, No. 1, Jan. 5, 1921, pp. 29–32, 5 figs. Notes on causes and factors effecting dust explosions. Types of industrial plants affected. Ignition temperatures, propagation and velocity of flame, pressures developed and relation of humidity and prevention of explosions.

The Prevention of Dust Explosions, Hylton R. Brown. Am. Industries, vol. 21, no. 6, Jan. 1921, pp. 27–29, 2 figs. Tests at Bureau of Chemistry, U. S. Dept. of Agriculture.

Eye Injuries. Factory Eye Room Saves Workers' Sight and Increases Output, Sanford DeHart. Indus. Management, vol. 61, no. 1, Jan. 1, 1921, pp. 23–24, 1 fig. Experience of R. K. LeBlond Machine Tool Co.

The Economic Aspect of Eye Injuries, T. Lister Llewellyn. Colliery Guardian, vol. 120, no. 3129, Dec. 17, 1920, p. 1749. Analysis of total accident claims made at a number of British coal and iron mines.

AERONAUTICAL INSTRUMENTS

Control Compass. A Remote Control Compass, Alfred Gradenwitz. Aviation, vol. 10, no. 1, Jan. 3, 1921, pp. 19–20, 7 figs. Bamberg remote control compass.

Route Indicator. Route Indicator (Le correcteur de route), M. Le Prieur. Aéronautique, vol. 2, no. 18, Nov.-Dec. 1920, pp. 227–232, 23 figs. Also Aérophile, vol. 28, no. 22–23, Nov. 1–15, 1920, pp. 326–332, 17 figs. Description of derivograph, an apparatus which indicates direction, corrected for wind, to follow in order to reach a certain place by flight in a straight line.

Turn Indiactor. Instruments for the Navigation of Aircraft, G. M. B. Dobson. Nature (Lond.), vol. 106, no. 2668, Dec. 16, 1920, pp. 504–506, 4 figs. Gyro turn indicator, gyro rudder control, pneumatic air log and bubble sextant.

AERONAUTICS

Flying Fish, Flight of. The Aeronautics of the Flying Fish, R. E. Dowd. Aerial Age, vol. 12, no. 18, Jan. 10, 1921, pp. 464–465, 4 figs. Study of forces acting. Mechanism of flight.

AEROPLANE ENGINES

Design. Some Possible Lines of Development in Aircraft Engines. H. R. Ricardo. Flight, vol. 12, no. 53, Dec. 30, 1920, pp. 1311–1316, 20 figs. Raising compression, proportioning mixture, and limiting size of cylinder. (Abstract.) Paper read before Royal Aeronautical Soc.

Engine Clearance Volumes. Instrument for Measuring Engine Clearance Volumes, S. W. Sparrow. Aerial Age, vol. 12, no. 16, Dec. 27, 1920, pp. 419–420, 6 figs. Apparatus designed and constructed under direction of Automotive Power Plants Section, Bureau of Standards.

Fuel. See GASOLINE, Hecter Fuel.

Hall-Scott. Building Motors on the Pacific Coast, Fred H. Colvin. Am. Mach., vol. 53, no. 27, Dec. 30, 1920, pp. 1215–1220, 29 figs., and vol. 54, no. 2, Jan. 13, 1921, pp. 46–47, 11 figs. Dec. 30: Machining of crankcases for both aircraft and marine types of motors. Jan. 13: Method of facing inside of aluminum-alloy piston.

Starting Torque. Starting Torque on Liberty, Hispano-Suiza, and Other Aviation Engines. Air Service Information Circular, vol. 2, no. 126, Nov. 6, 1920, 3 pp. Starting torque required for Liberty engine of 400-hp. rating and with 12 cylinders was 124 lb-ft. with throttle open and 143 with throttle closed; for Hispano-Suiza of 300 hp. with 8 cylinders, these figures were respectively 102 and 96.

AEROPLANE PROPELLERS

Design. The Metal Airscrew, M. A. S. Riach. Aeronautics, vol. 19, no. 375, Dec. 23, 1920, pp. 450 and 459, 2 figs. Metal versus wood for aeroplane propellers.

Gear Drive. Experience with Geared Propeller Drives for Aviation Engines, K. Kutzbach. Aerial Age, vol. 12, nos. 17 and 18, Jan. 3 and 10, 1921, pp. 442–445, 9 figs., and 466–469, 18 figs. Stresses in gear wheels; table of gears from captured engines; arrangements of gear. Translated from Technische Berichte.

AEROPLANES

Design. Aeroplane Design, F. S. Barnwell. Aeronautics, vol. 19, no. 376, Dec. 30, 1920, pp. 466–467, 1 fig. Present tendencies and future possibilities. (To be continued.)

Structural Analysis and Design of Aeroplanes, B. C. Boulton and A. S. Niles. Aerial Age, vol. 12, no. 18, Jan. 10, 1921, pp. 469–470. Review of book by B. C. Boulton in charge of stress analysis and structural design, McCook Field.

Farman. Recent Farman Types of Aeroplanes (Die neueren Farman-Flugzeuge), Luftfahrt, vol. 24, no. 10, Oct. 7, 1920, pp. 145–147, 3 figs. Details of various Farman types which are then compared to corresponding German types, including the Dornier, Junkers, Sablatnig and Fokker, showing, in writer's opinion, the greater advance made in aeroplane construction in Germany during last six years.

Gastambide-Levavasseur. Aeroplanes in Which the Three Elements, Surface, Curvature and Incidents are Variable (L'avion a surface, courbure et incidence variables), Georges Blanchet. Aérophile, vol. 28, no. 22–23, Nov. 1–15, 1920, pp. 321–325, 4 figs. Description of Gastambide-Levavasseur machine.

Helicopters. See HELICOPTERS.

Large, Possibilities of. The Possibilities of the Large Airplane, F. H. Norton. Aviation, vol. 10, no. 2, Jan. 10, 1921, pp. 48–50, 10 figs. Structural and aerodynamic problems of large aeroplane.

Longitudinal Stability. Statical Longitudinal Stability of Airplanes, Edward P. Warner. Nat. Advisory Committee for Aeronautics, report no. 96, 1920, 28 pp., 14 figs. Results of experimental work, together with details of theoretical analysis of statical stability, of factors which affect it, and of methods which can be employed for its modification.

Model Tests. Value of Model Tests, J. W. Margoulis. Aviation, vol. 10, no. 2, Jan. 10, 1921, pp. 40–42, 1 fig. Influence of ratio of dimensions of model and speed of test to dimensions of full scale machine and its speed of flight.

Single-vs.-Twin-Engined. A Comparison of the Flying Qualities of Single and Twin-Engined Aeroplanes. Aeronautical Jl., vol. 24, no. 120, Dec. 1920, pp. 616–627. Factors in design which are most vital to pilot and how they influence his handling of aeroplane.

Stability. Diagrams of Airplane Stability, H. Bateman. Nat. Advisory Committee for Aeronautics, report no. 95, 1920, 25 pp., 28 figs. Effect on period and rate of subsidence of pitching oscillations of an airplane of a change in one of resistance derivatives when all others are kept constant.

Wind Tunnels. See WIND TUNNELS.

Wings. Slotted Airplane Wings. Sci. Am. Monthly, vol. 3, no. 1, Jan. 1921, pp. 66–67, 2 figs. Handley Page wings of Venetian blind form.

The Handley-Page Wing (L'aile Handley-Page) E.-H. Lemonon. Aérophile, vol. 28, no. 22–23, Nov. 1–15, 1920, pp. 333–334, 9 figs. Wing is made up of separate elements which separate or come together like Venetian blind.

AIR

Dust-Content Determination. Efficiency of the Palmer Apparatus for Determining Dust in Air, S. H. Katz, E. S. Longfellow and A. C. Fieldner. Jl. Am. Soc. Heat. and Vent. Engrs., vol. 26, no. 8, Nov. 1920, pp. 687–700, 5 figs. Two methods of testing were used. In first efficiency was determined on basis of surface of particles entering apparatus as compared with surface leaving, by use of Tyndall effect. Second method was based on weight of dust, and used small laboratory Cottrell precipitator in series with Palmer washer.

AIR COMPRESSORS

Centrifugal. The General Behavior of the Centrifugal Compressor (Das allgemeine Verhalten der

Copyright 1921, by THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

NOTE.—The abbreviations used in indexing are as follows:

Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

Kreiselverdichter), Gustav Flügel. Zeit. des Vereines deutscher Ingenieure, vol. 64, no. 49, Dec. 4, 1920, pp. 1027–1032, 4 figs. Under presumption of unchangeable air temperature the compression phenomenon with the multi-stage centrifugal compressor for any working conditions is investigated, first according to a very accurate method and then according to a simple approximate method. It is shown that the equations derived define the variable air temperature with the same accuracy, providing the mean temperature is calculated.

Heat Utilization. The Economic Utilization of the Compression Heat in Large Compressors (Die wirtschaftliche Ausnutzung der Kompressionswärme in grösseren Verdichtern), Erich Lampel. Fördertechnik u. Frachtverkehr, vol. 13, no. 21, Oct. 15, 1920, pp. 193–195, 2 figs. Heat resulting from compression said to be a drawback. Utilization of latent heat according to method heretofore used of introducing cooling water is claimed to be impossible, and a new arrangement is described for admission of cooling water and intermediate cooling, resulting in considerable reduction of volume of water and increase in temperature drop. Its useful possibilities are set forth.

High-Pressure. High-Pressure Air and Gas Compressors. Eng., vol. 110, no. 2869, Dec. 24, 1920, pp. 829–831, 3 figs. Six-Stage 4500-lb. per sq. in. compressor built to order of British admiralty for naval experimental station described in second installment.

Steam-Driven High-Pressure Four-Stage Gas Compressor. Eng., vol. 110, no. 2868, Dec. 17, 1920, pp. 800–802, 12 figs., partly on supp. plate. Two types, one compressing to 2250 lb. in four stages and other to 4500 lb. in six stages. Former type is described in first installment. (To be continued.)

Manufacture. Building Air Compressors. Eng. Production, vol. 2, no. 14, Jan. 6, 1921, pp. 7–12, 14 figs. Manufacturing methods in plant of Reavell & Co., Ipswich, England.

AIR CONDITIONING

Humidifier. Physiological Heat Regulation and the Problem of Humidity, E. P. Lyon. Jl. Am. Soc. Heat. and Vent. Engrs., vol. 26, no. 8, Nov. 1920, pp. 677–685. Importance of using humidifier in connection with heating system in houses and factories.

AIR SERVICE, UNITED STATES

United Force. United Air Force - Pro and Con. Aviation, vol. 9, no. 15, Dec. 27, 1920, pp. 480–482. Survey of reasons which reflect position of many Naval officers for united service and reasons of many Army officers who favor separate department.

AIRSHIPS

Mooring. Airship Mooring and Handling. F. L. C. Butcher. Aeronautics, vol. 19, no. 374, Dec. 16, 1920, pp. 432–435. Advantages and disadvantages of windscreens. Experiments with drogues. Paper read before Royal Aeronautical Soc.

Piloting. Airship Piloting. G. H. Scott. Flight, vol. 12, no. 50, Dec. 9, 1920, pp. 1254–1258. Difficulties encountered in airship piloting and methods employed to overcome these difficulties. Paper read before Royal Aeronautical Society.

Rigid. Operation of a Rigid Airship, L. H. Maxfield. Aviation, vol. 10, no. 1, Jan. 3, 1921, pp. 15–16. Duties of airship crew.

ALCOHOL

See AUTOMOBILE FUELS, Alcohol.

ALUMINUM

Castings. Analyze Loss in Aluminum Shops—II, Robert J. Anderson. Foundry, vol. 49, no. 1, Jan. 1, 1921, pp. 16–21. Effect on casting losses of stock used in melting charge and also of pouring temperature and melting practice, including type of furnace used.

Density. Density of Aluminum from 20 to 1000 Deg. Cent., Junius David Edwards and T. A. Moormann. Chem. & Metallurgical Eng., vol. 24, no. 2, Jan. 12, 1921, pp. 61–64, 3 figs. Experimental methods for measuring with precision density of liquid metals, and figures for results when applied to pure aluminum. Derived data of importance are solid shrinkage, or pattern allowance, and solidification shrinkage.

Soldering of. The Practicability of Soldering Aluminum, A. N. Fleming. Sheet Metal Worker, vol. 11, no. 15, Dec. 24, 1920, pp. 427 and 433, 1 fig. How aluminum transmission case was repaired by soldering.

ALUMINUM ALLOYS

Magnesium. The Constitution of the Alloys of Aluminium and Magnesium, D. Hanson and Marie L. V. Gayler. Eng., vol. 110, nos. 2867–2868, Dec. 10–17, 1920, pp. 788–791 and 17 figs., 819–821, 18 figs. Research carried out in Metallurgy Department of National Physical Laboratory, England. Determination of solidus. Photomicrographs. Abstract of paper read before Inst. Metals.

AMMONIA

Properties. Properties of Ammonia. Refrigerating World, vol. 55, no. 12, Dec 1920, pp. 21–28. Tables prepared by National Bureau of Standards with coöperation of American Society of Refrigerating Engineers.

AMMONIA COMPRESSORS

Development. The development of the Modern High Efficiency Ammonia Compressor Through the Application of the Worthington Feather Valve, Thos. D. McKee. Ice & Refrigeration, vol. 60, no. 1, Jan. 1921, pp. 13–15. Advantages of high speed ammonia compressors.

APPRENTICES, TRAINING OF

Machinists. Training Operators in a Machine Shop, John C. Spence. Machy. (N. Y.), vol. 27, no. 5, Jan. 1921, pp. 421–423, 2 figs. Methods employed in plant of Norton Co., Worcester, Mass., in training of machine-shop workers.

Work of the German Committee for Technical Instruction in the Training of Apprentices in the Metal Industry (Die Arbeiten des Deutschen Ausschusses für Technisches Schulwesen auf dem Gebiete der Lehrlingsausbildung in der Metallindustrie), A. Heilandt. Betrieb, vol. 3, no. 5, Dec. 10, 1920, pp. 13–20, 15 figs. Work already completed: Course for training of apprentices for machine construction; curriculum for schoolroom instruction of apprentices for machine construction; workshop textbook.

Training the Machinist of the Future, J. H. Moore. Can. Machy., vol. 25, no. 2, Jan. 13, 1921, pp. 33–38, 12 figs. Organization and operation of Hamilton Technical & Art School.

Railroad Shop. A Railroad Shop's Apprentice School, J. V. Hunter. Am. Mach., vol. 54, no. 3, Jan. 20, 1921, pp. 97–98, 1 fig. Training school in Decatur locomotive and car shops of Wabash Railway Co. Current expenses defrayed by assessing apprentices. Regular and helper courses given.

Systems. Programs of Apprenticeship and Special Training in Representative Corporations—VIII, J. V. L. Morris. Am. Mach., vol. 54, no. 1, Jan. 6, 1921, pp. 13–14, 4 figs. System at plant of United Shoe Machinery Co., Beverly, Mass. Boys attend school and shop on alternate weeks and school work is given in coöperation with public-school system.

ASH HANDLING

Pneumatic Plants. Pneumatic Ash-Removal Installations in Heating Plants (Pneumatische Entaschungsanlagen in Heizwerken), W. Uhlig. Elektrotechnische Rundschau, vol. 37, nos. 16 and 17, Aug. 21 and Sept. 7, 1920, pp. 73–75 and 79–81, 6 figs. It is claimed that in spite of fact that power consumption of installations with impeller exhausters is generally high as compared to those with piston pumps, they have great advantages including lack of sensitivity to smoke and hot gases.

AUTOGENOUS WELDING

Cylinder Repair Work. Cylinder Repair Work, Wabash Shops, Decatur, Illinois, J. G. Cunningham. Autogenous Welding, Jan. 1921, pp. 36–38, 8 figs. Examples of repairs made at Wabash Railroad shops.

AUTOMOBILE ENGINES

Carburetors. See CARBURETORS.

Connecting Rods. Making Connecting-Rods for Franklin Cars, Franklin D. Jones. Machy. (N. Y.), vol. 27, no. 5, Jan. 1921, pp. 470–474, 11 figs. Machines and fixtures used at plant of H. H. Franklin Mfg. Co., Syracuse, N. Y., for orilling, boring, milling, grinding, reaming and gaging operations.

Cylinders. See CYLINDERS, Manufacture.

Design. Possible Fuel Savings in Automotive Engines, H. C. Dickinson and S. W. Sparrow. Jl. Soc. Automotive Engrs., vol. 8, no. 1, Jan. 1921, pp. 3–9, 14 figs. Notes on design of manifold and chemical operation of automotive engines. Paper read before Am. Petroleum Inst.

Gasoline Losses. Gasoline Losses Due to Incomplete Combustion in Motor Vehicles, A. C. Fieldner, A. A. Straub and G. W. Jones. Jl. Indus. & Eng. Chem., vol. 13, no. 1, Jan. 1921, pp. 51–58, 7 figs. Results of tests under spring and summer conditions.

Horsepower Formulas. A Compilation of the Horsepower Formulas for Different Countries (Zusammenstellung der Steuerformeln für verschiedene Länder), Richard Bussien. Motorwagen, vol. 23, no. 28, Oct. 10, 1920, p. 527. Gives German, Belgian, French, English, Swedish, Italian, Japanese, Spanish, Hungarian and Californian formulas.

New York Show. Engines Exhibited at New York Show, P. M. Heldt. Automotive Industries, vol. 44, no. 2, Jan. 13, 1921, pp. 53–58, 15 figs. Survey of exhibits.

Suspension. A New Principle of Engine Suspension, S. E. Slocum. Jl. Soc. Automotive Engrs., vol. 8, no. 1, Jan. 1921, pp. 54–56, 1 fig. Suspension on three points so as to destroy synchronism between oscillating machine and support so far as transmission of vibrations is concerned.

AUTOMOBILE FUELS

Alcohol. Significance of Alcohol in the Motor Fuel Problem, Burnell R. Tunison. Automotive Industries, vol. 44, no. 1, Jan. 6, 1921, pp. 14–17, 5 figs. Advantages of and need for using synthetic fuel containing alcohol. Data regarding performance of engines using alcohol.

Benzol. The Manufacture of Motor Spirit in Gasworks. Gas World, vol. 73, no. 1900, Dec. 18, 1920, pp. 493–494. Stripping process of benzol recovery and its financial results.

Gasoline. See GASOLINE.

Palm Oil. Belgian Experiments on Palm Oil as Motor Fuel. Commerce Reports, no. 1, Jan. 3, 1921, pp. 10–11. Series of experiments begun 1914, but interrupted by war, has recently been resumed in Brussels on use of palm oil in internal-combustion motors. Tests have so far proven satisfactory.

AUTOMOBILES

Body Design. American and British Bodywork at Olympia Compared, M. W. Bourdon. Automotive Industries, vol. 43, no. 26, Dec. 23, 1920, pp. 1256–1261, 12 figs. American bodies said to lack finish and comfort as compared to British product selling in England at same price. British cars generally have lower seats but thicker cushions tilted toward rear and greater freeboard.

Body Suspension. Study of Suspension on Automobile Bodies and of Shock Absorbers (Étude sur la suspension des véhicules et les amortisseurs), G. Puica. Vie Technique & Industrielle, vol. 2, no. 14, Nov. 1920, pp. 117–120, 4 figs. Formula for designing springs. Study of stresses in spring plates.

The Mutti Suspension. Autocar, vol. 46, no. 1315, Jan. 1, 1921, p. 8, 2 figs. Design employing variable-tension coil spring. It has been tested with trailer and is suggested as substitute for ordinary car suspension.

Brakes on Four Wheels. Another French Car Using Brakes on Four Wheels, W. F. Bradley. Automotive Industries, vol. 43, no. 26, Dec. 23, 1920, pp. 1266–1268, 7 figs. Darracq now getting into production on eight-cylinder car, which has been modified since exhibit at Paris Salon a year ago. Engine has removable heads and uses battery ignition. Four-speed transmission and spiral-bevel final drive employed. Right-hand drive retained.

Design. European Automobile Design for 1921. Sci. Am., vol. 124, no. 1, Jan. 1, 1921, pp. 9 and 19–20. Comparison of European and American Practices.

Friction Drive. Friction Drive Revived in New Kelsey Six-Cylinder Car. Automotive Industries, vol. 43, no. 25, Dec. 16, 1920, pp. 1204–1206, 3 figs. Friction disk and wheel are located within rear axle housing, which is of aluminum alloy and is said to be lighter than standard type. Jackshaft carries helical pinion meshing with internal gear on wheel hub, giving 4.5 to 1 reduction. Wheelbase is 116 in. Engine $3^1/_8$ x $4^1/_4$ in. Falls.

Headlights. Report of the Committee on Automobile Headlighting Specifications. Trans. Illuminating Eng. Soc., vol. 15, no. 9, Dec. 30, 1920, pp. 848–866. Recommended practice in headlamp illumination.

Manufacture. More Power for Automobile Building. Power Plant Eng., vol. 25, no. 2, Jan. 15, 1921, pp. 101–110, 17 figs. New plant of Cadillac Motor Car Co., Detroit, Mich.

Metal Construction. Substitute Metals in Automobile Construction. Benno R. Diezfeld. Automotive Industries, vol. 43, no. 27, Dec. 30, 1920, p. 1309. How copper and aluminum were substituted for iron and steel in Germany during war.

Rear-Axle Housings. Machining Columbia Rear-Axle Housings. Fred H. Colvin. Am. Mach., vol. 54, no. 1, Jan. 6, 1921, pp. 27–30, 15 figs. Operations on drilling, boring, reaming, tapping machines, Press work assembling and testing.

Sheet Metal Work. Sheet Metal Work for Automobiles, Fred H. Colvin. Am. Mach., vol. 53, no. 26, Dec. 23, 1920, pp. 1165–1168, 16 figs. Machinery for stamping and cutting up strips into various lengths and also preparing material for presses.

Transmissions. Clutches, Transmissions and Universal Joints, Herbert Chase. Automotive Industries, vol. 44, no. 2, Jan. 13, 1921, pp. 79–81, 4 figs. Trend of design as revealed at New York Show.

Wheels, Steel-Disk. The Harvey Steel Disk Wheel. Automotive Industries, vol. 43, no. 25, Dec. 16, 1920, p. 1206, 2 figs. Design in which attempt has been made to reduce or eliminate rigidity characteristic of metal wheels.

AVIATION

Commercial. Commercial Aircraft, B. W. Townshend. Aeronautics, vol. 19, no. 373, Dec. 9, 1920, pp. 421–423, 1 fig. Position of airships and aeroplanes in future of aerial transport. Paper read before City and Guilds Engineering Society.

Commercial Aviation in Great Britain (La navigation commerciale aérienne en Grande-Bretagne)—I. Génie Civil, vol. 77, no. 23, Dec. 4, 1920, pp. 456–460, 1 fig. Models submitted for air ministry competition held in September 1920. (To be continued.)

Developments. Recent Advances in Aviation, Thurman H. Bane. Jl. Soc. Automotive Engrs., vol. 8, no. 1, Jan. 1921, pp. 18–25, 26 figs. Aeroplanes and aeroplane engines developed during war.

Nationality Marks. International Aircraft Marking, Ladislas d'Orey. Aviation, vol. 9, no. 15, Dec. 27, 1920, pp. 484–486, 3 figs. Nationality and registration marks for aircraft. Proposed table of nationality marks.

Night Flying. Night Flying. Aeronautical Jl., vol. 24, no. 120, Dec. 1920, pp. 627–642 and (discussion) pp. 643–649. Experience during war. Best type of machine for night flying.

[See also FLIGHT.]

AVIATORS

Fatigue of. The Human Machine in Relation to Flying. Aeronautical Jl., vol. 24, no. 120, Dec. 1920, pp. 650–658 and (discussion) pp. 658–663. Reasons why pilots should have periodic intervals of rest. International convention fixed period of six months for civilian pilot.

Tests of. Observation, Selection, and Assignment. Air Service Information Circular, vol. 2, no. 120, Oct. 30, 1920, 8 pp. Qualities needed by aviators. Process of selecting from application.

B

BALANCING MACHINES

Rotors, High-Speed. Rotor Balancing Machine. Eng., vol. 110, no. 2866, Dec. 3, 1920, pp. 737–738, 2 figs. Machine devised by N. W. Akimoff for testing both static and dynamic balance of high-speed rotors.

BALLOONS

Sunlight, Effect of. Solar Radiation and Balloons, Junius David Edwards and Maurice Blaine Long. Aviation, vol. 9, no. 15, Dec. 27, 1920, pp. 487–490, 4 figs. Investigations at Bureau of Standards of effect of sunlight upon life and operating characteristics of lighter-than-air craft.

BEAMS

Vibrations from Shafting. See SHAFTS, Whirling Speeds.

BEARINGS

Manufacture. Modern Bearings (Les paliers modernes). Nature (Paris), no. 2428, Oct. 16, 1920, pp. 243–246, 2 figs. Developments in manufacture, with reference to type developed by Brown Boveri Co.

Self-Lubricating. Self-Lubricating Bearings. Iron Age, vol. 107, no. 2, Jan. 13, 1921, p. 146. Reliance type consisting of inner and outer casings joined by force fit. Tapered holes in inner casing are filled with lubricating mixture under pressure.

Testing. Testing Hardness of Bearings and Journal. Iron Age, vol. 106, no. 27, Dec. 30, 1920, pp. 1727–1730, 16 figs. Progress report of subcommittee on bearing metals of The American Society of Mechanical Engineers. Description of tentative scale of so-called microhardness that expresses in definite units relation of hardness between different materials.

BELTING

Balata. The Manufacture of Balata Belting. India Rubber World, vol. 63, no. 4, Jan. 1, 1921, pp. 236–238, 16 figs. Translated from Le Caoutchouc et la Gutta Percha.

Leather. A New Type of Leather Belt. Eng., vol. 130, no. 3389, Dec. 10, 1920, pp. 590, 2 figs. Patented by French inventor. Belt consists of backing 3 in. by 1/4 in. oak-tanned leather to underside of which are riveted three stips of chrome leather, each strip being about 9/16 in. wide by 6/32 in. thick. Attachment of strips to backing is effected by means of brass rivets pitched at 2 in. intervals.

Effect of Relative Humidity on Leather Belting, F. W. Roys. Belting, vol. 18, no. 1, Jan. 1921, pp. 40–48, 9 figs. Also Textile World Jl., vol. 59, no. 2, Jan. 8, 1921, pp. 93–97, 9 figs. Tests at Worcester Polytechnic Institute. With adjustments of regular oak belts at 55 per cent humidity, no change was found to either tighten or slacken belt so as to cause trouble.

BLAST-FURNACE GAS

Purification. Purification of Blast Furnace Gas (État actuel de l'épuration des gaz de hauts-fourneaux), M. Alexandre Gouvy. Revue de Métallurgie, vol. 17, no. 10, Oct. 1920, pp. 677–686, 7 figs. Dscription of Cottrell process using electricity at high tension.

BLAST FURNACES

Coke Efficiency. Blast Furnace Problems of Today. C. E. Roberts. Eng. & Indus. Management, vol. 5, no. 1, Jan. 6, 1921, pp. 7–10. Coke efficiency, increase in moisture content, dust difficulty, scientific control of furnace working. Paper read before Staffordshire Iron & Steel Inst.

Operation, Chile. Green Wood in the Blast Furnace: François Prudhomme. Iron Age, vol. 107, no. 2, Jan. 13, 1921, pp. 121–122. Making pig iron of tofo ores at Corral, Chile. Wood charred in upper part of furnace and distillates recovered. Chilean Government report.

Reducing Reactions. Reducing Reactions in the Blast Furnace (Des réactions réductrices dans le haut fourneau), Em. Pierre. Revue universelle des mines, vol. 7, no. 5, Dec. 1, 1920, pp. 301–321, 5 figs. Researches showed that reaction by CO is best for reducing FeO. Studies of action of gas on minerals.

Slags. Sampling Blast Furnace Slags, W. M. Chegwidden. Iron Trade Rev., vol. 67, no. 26, Dec. 23, 1920, pp. 1750–1751. Relation of sulphur in slag to sulphur in pig iron.

BOILER FEEDWATER

Heating, Economic Advantages of. Exhaust Wastes. Power Plant Eng., vol. 25, no. 1, Jan. 1, 1921, pp. 72–74, 2 figs. Chart showing percentage of fuel saved by heating feedwater by exhaust steam.

BOILER FURNACES

See FURNACES, Boiler.

BOILER ROOMS

Design. Design of Large Boiler Plants, J. Grady Rollow. Jl. Am. Soc. Heat. and Vent. Engrs., vol. 26, no. 8, Nov. 1920, pp. 715–734, 10 figs. Typical double-wall boiler plant with furnace for burning coal and dry wood waste.

Economical Operation. Reducing Operating Costs in Boiler Rooms, John Rusen. Coal Industry, vol. 4, no. 1, Jan. 1921, pp. 14–18, 8 figs. Advises mechanical conveying for coal and ashes will materially reduce costs.

Remodeling. Remodeling Old Power Stations—Boiler-Plant Improvements, L. R. Lee. Power, vol. 52, no. 26, Dec. 28, 1920, pp. 1004–1007, 1 fig. Economical methods of increasing capacity of boiler plants.

BOILER TUBES

Soot Blower. New Steam Tube Blower. Iron Age, vol. 106, no. 26, Dec. 23, 1920, p. 1670. 2 figs. Swedish device for removing soot and scale from stationary boiler tubes.

BOILERS

Cast-Iron vs. Wrought-Iron. Cast Iron versus Wrought Iron (Gusseisen oder Schmiedeeisen?), Otto Ginsberg. Gesundheits-Ingenieur, vol. 43, no. 41, Oct. 9, 1920, pp. 479–487. Contribution to the boiler problem in central heating plants. It is concluded that in case of careful manipulation of boiler, cast iron is superior to wrought iron for small and medium-size plants, but for very large plants the wrought-iron boiler is preferable.

Electrically Heated. Bergeon-Frédet Electrically Heated Steam Boiler (Le générateur de vapeur "Bergeon-Fredet" à chauffage électrique). Chaleur et Industrie, no. 7, Oct. 1920, pp. 403–405, 3 figs. Horizontal cylindrical type boiler heated by three-phase current of 50 periods under tension of 6300 volts.

Electrically Heated Boilers. Elec. Times, vol. 58, no. 1523, Dec. 23, 1920, p. 491, 2 figs. Boilers manufactured by Sulzer Bros., London.

Manhole Cutting. Ellipsograph for Manhole Cutting. Eng., vol. 110, no. 2868, Dec. 17, 1920, p. 817, 3 figs. Patented device.

Marine. See MARINE BOILERS.

Massachusetts Board Boiler Rules. Changes in Massachusetts Boiler Rules. Power Plant Eng., vol. 25, no. 2, Jan. 15, 1921, pp. 121–122. Changes adopted at public hearing held by Board of Boiler Rules.

Performance. Exact Data on the Performance of Steam Boiler Plants—IV, David Brownlie. Eng., vol. 110, nos. 2867–2868, Dec. 10–17, 1920, pp. 759–761 and 797–799. Average figures for performance of a number of different types of steam boilers.

Tubes. Influence of Expanding of Tubes on the Deformation of Tube Sheets of Locomotive Boilers (Influence du sertissage des tubes dans les déformations des plaques tubulaires de foyer des chaudieres locomotives), M. Haffner. Revue generale des Chemins de Fer, vol. 39, no. 4, Oct. 1920, pp. 133–138, 5 figs. Comparison of various methods of expanding.

BOILERS, WATER-TUBE

Connelly. Connelly Water-Tube Boilers. Can. Manufacturer, vol. 41, no. 1, Jan. 1921, pp. 76–77, 2 figs. Boilers of large capacity built for working pressure of 300 tons per sq. in.

BORING MACHINES

Horizontal. Rockford Heavy-Duty Horizontal Boring Machine. Am. Mach., vol. 53, no. 26, Dec. 23, 1920, pp. 1197–1198, 2 figs. Machine intended chiefly for work encountered in automotive field.

Taper-Turning Head. New Taper-Turning Head for Vertical Boring Mills. Engr., vol. 130, no. 3385, Nov. 12, 1920, p. 485, 5 figs. Attachment manufactured by George Richards & Co., Ltd., Broadheath, England.

BRAKES

Street-Car. A New Tramcar Brake. Engr., vol. 130, no. 3391, Dec. 24, 1920, pp. 642–643, 4 figs. Spencer-Dawson brake.

The Force Action of Brake Riggings, H. M. P. Murphy. Elec. Ry. Jl., vol. 57, no. 3, Jan. 15, 1921, pp. 116–119, 11 figs. Forms of levers used in brake rigging of electric cars. Study of forces acting at various points of levers.

BUSES

Trolley-Operated. Trackless Trolley in Two British Cities. Elec. Ry. Jl., vol. 57, no. 2, Jan. 8, 1921, pp. 77–79, 5 figs. Bradford, with three routes in operation, is planning three more. Buses are used as feeders for trolley system. Double-deck trackless-trolley bus has just been put in service, Keighley, after five years' experience, has added to its equipment, and now has nine buses in service.

C

CABLEWAYS

Design. Didactic Study of Aerial Cableways (Étude didactique des transporteurs aériens sur cables), Giulio Ceretti. Génie Civil, vol. 77, no. 22, Nov. 27, 1920, pp. 430–435, 12 figs. Details of design of cable junctions and suspension methods. (Concluded.)

CANALS

Electric Haulage of Barges. New Systems of Electric Haulage in Canals (Nouveaux systèmes de halage électrique sur les canaux), Édouard Imbeaux. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 21, Nov. 22, 1920, pp. 981–985. Recent developments in France.

CARBURATION

Theory of. Contribution to the Problem of Carburation (Contribution au "sujet" de la carburation), A. Grebel. Chaleur & Industrie, no. 8, Nov.-Dec. 1920, pp. 455–473, 15 figs. Technical study of principles upon which carburation is based and of their application to the carburation of gasoline engines and gas engines together with investigation of chemical practicability of utilizing gas as fuel in automobile engines.

CARBURETORS

Claudel. New Carburetor Construction Types (Neue Vergaser-Konstruktionen), H. Praetorius. Motorwagen, vol. 23, no. 30, Oct. 31, 1920, pp. 572–578, 12 figs. Details of the three types of Claudel automobile carburetors, the Eureka, Graetzin, Lacharnay, Standard, Einhorn and Asmo carburetors.

Einhorn. The Einhorn Carburetor (Der Einhorn-Vergaser), Johannes Menzel. Allgemeine Automobil-Zeitung, vol. 21, no. 41, Oct. 9, 1920, pp. 26–28, 2 figs. Describes automatically adjustable carburetor for use of heavy fuels of all kinds, which won first prize at tests carried out by Gen. German Automobile Club in conjunction with Automotive Testing Commission.

Floatless. Floatless Carburetors Coming Into Use in Germany, Benno R. Dierfeld. Automotive Industries, vol. 43, no. 26, Dec. 23, 1920, pp. 1262–1265, 11 figs. Developments in carburetor design in Germany.

CARS

Ball Bearings for. Ball Bearings for Railway Cars. Ry. Mech. Engr., vol. 95, no. 1, Jan. 1921, pp. 23–24, 5 figs. Graphs of train resistance with journal bearings and with disk bearings.

Diesel-Electric Self-Propelled. Diesel-Electric Self-Propelled Railway Coaches. Engr., vol. 130, no. P3386, Nov. 19, 1920, p. 511. Swedish design, Translated from Génie Civil.

CASE-HARDENING

Furnace for. A New Method of Case-Hardening Steel, Wm. J. Merten. Am. Mach., vol. 53, no. 26, Dec. 23, 1920, pp. 1169–1170, 1 fig. Regenerative type of furnace.

CASTINGS

Die. Die Castings, W. Betterton. Metal Industry (London), vol. 17, no. 24, Dec. 10, 1920, pp. 461–464, 8 figs. Manufacture of castings are accurately cast to limit of one-thousandth of an inch so that no machining is necessary. Alloys from which such castings can be made are discussed and advantages of die casting are pointed out.

Inspection. Precise Inspection of Large and Irregular Curves, Elbert O. Brower. Am. Mach., vol. 54, no. 2, Jan. 13, 1921, pp. 60–66, 13 figs. Method for inspection of large and irregular curves, and its application to inspection of castings.

Iron. See IRON CASTINGS.

Malleable. Shop Specializes in Annealing Pots. Foundry, vol. 49, no. 1, Jan. 1, 1921, pp. 11–15, 7 figs. Manufacture of malleable castings on production basis.

Steel. See STEEL CASTINGS.

CEMENT

Natural. Australian Company to Work an Island of Cement Rock. Cement, Mill & Quarry, vol. 18, no. 1, Jan. 5, 1921, pp. 19–22, 5 figs. Concessions for operating deposits of natural cement located on Maria Island on east coast of Tasmania have been secured by National Portland Cement Co.

Setting Time. Modified Vicat Apparatus for Study of Setting Time of Cement, O. L. Moore. Eng. News-Rec., vol. 86, no. 2, Jan. 13, 1921, p. 70, 3 figs. Principle consists in balancing rod and needle by means of beam and weight and determining load necessary at time intervals to cause needle to penetrate definite distance into neat paste.

CEMENT, PORTLAND

Consolidation. Judging the Quality of Portland Cement, R. J. Colony. Min. & Metallurgy, no. 169, Jan. 1921, pp. 30–31, 1 fig. Triangular concentration diagram showing end products of consolidation. (Abstract.)

Specifications. British Standard Specification for Portland Cement. Eng. World, vol. 18, no. 1, Jan. 1921, pp. 5–8, 4 figs. Specifications of British Standards Engineering Association, revised in 1920.

Wet Process. Development in Wet Process Portland Cement Plants—II. Rock Products, vol. 24, no. 2, Jan. 15, 1921, pp. 39–44, 12 figs. Description of process at plant of Bessemer Limestone & Cement Co., Bessemer, Pa., from kilns to finished product.

CENTRAL STATIONS

Isolated Plants vs. Power Development in the Future, Lazarovich-Hrebellianovich. Power, vol. 52, no. 19, Nov. 9, 1920, pp. 744–747. Comparative study of central stations and isolated plants.

Mineside. Modern Central Power Station in Center of a Coal Mining District, F. G. Hickling. Coal Industry, vol. 4, no. 1, Jan. 1921, pp. 24–27, 7 figs. Riversville Central Station of Monongahela Valley Traction Co., Fairmont, W. Va. Two 12,500-kva. turbine generator units have been installed and additional 25,000 kva. unit has been ordered.

Operation in U. S. Output for 1920 Estimated at 46,700,000,000 Kw-Hr. Elec. World, vol. 77, no. 1, Jan. 1, 1921, pp. 45–46, 2 figs. Statistics of central station operations in United States.

CHIMNEYS

Steel, Copper-Smelter. Steel Chimneys and Their Linings in Copper Smelting Plants, A. G. McGregor. Min. & Metallurgy, no. 167, Nov. 1920, p. 34. It is concluded from experiments at various plants that unlined steel chimneys do not give satisfactory service when used for roaster furnaces or reverberatory furnaces, but they will prove serviceable for long periods when used for blast furnace and converter gases. Building tile has proved unsatisfactory for chimney linings or for construc-

tion of walls for flues and dust chambers where exposed to roaster furnace gases or cool reverberatory furnace gases. (Abstract.)

COAL

Pulverized. See PULVERIZED COAL.

Utah, Coking Properties. Low-Temperature Coking of Utah Coals, Osborn Monnett. Chem. & Metallurgical Eng., vol. 23, no. 26, Dec. 29, 1920, pp. 1246–1249, 2 figs. Summarized description of laboratory investigations made to determine coking property of series of Utah coals. Analysis of coals tested. Apparatus used. Tabulated results obtained.

COAL HANDLING

Hydraulic Conveyors. Conveying Bulk Material Through Pipes, George Frederick Zimmer. Eng. & Indus. Management, vol. 4, no. 25, Dec. 16, 1920, pp. 791–792, 3 figs. Scheme for handling coal hydraulically.

Power Plants. Fuel Handling. Power Plant Eng., vol. 25, no. 1, Jan. 1, 1921, pp. 2–14, 19 figs. Comparison of various methods of handling fuel economically in power plant.

New Station at Baltimore Has Unique Coal-Handling Method, M. D. Engle. Elec. World, vol. 77, no. 3, Jan. 15, 1921, pp. 133–137, 7 figs. How coal, received by water is handled at Westport Station. Method of load division with holtwood hydroelectric plant. Provision against generator fires and ceiling condensation among other features.

COAL STORAGE

Methods. Coal Storage. Power Plant Eng., vol. 25, no. 1, Jan. 1, 1921, pp. 14–23, 13 figs. Methods of storing coal in piles in the open, and arrangement of conveyors to carry coal to plant.

COAL TIPPLES

Construction. Mine of the Washington Gas Coal Company and Advances in Tipple Construction, J. O. Durkee and Frank A. Dowling. Coal Industry, vol. 4, no. 1, Jan. 1921, pp. 11–12 and 74–76, 5 figs. Tipple is arranged to coal locomotives, ship by truck or rail and supply Tyrler Tube Co. located near tipple.

COKE

Blast-Furnace. Determination of the Hardness of Blast-Furnace Coke. Owen R. Rice. Min. & Metallurgy, no. 167, Nov. 1920, pp. 34–35. Soft coke is deprecated for proper blast furnace operation. Methods of measuring coke hardness. (Abstract.)

House Heating with. By-Product Coke, Anthracite, and Pittsburgh Coal as Fuel for Heating Houses, Henry Kreisinger. Jl. Indus. & Eng. Chem., vol. 13, no. 1, Jan. 1921, pp. 31–33, 1 fig. Based on tests made at fuel laboratory of Bureau of Mines, Pittsburgh.

Metal Melting with. Coke and By-Products as Fuels for Metals Meltings, F. W. Sperr, Jr. Min. & Metallurgy, no. 167, Nov. 1920, p. 33. Growth of use of coke-oven tar as metallurgical fuel during past few years. With properly selected coals, modern by-product coke plant will produce straight gas having heating value of 560 B.t.u. per cu. ft. after removal of benzols. (Abstract.)

COKE MANUFACTURE

By-Product. By-Product Coking, F. W. Sperr, Jr., and E. H. Bird. Jl. Indus. & Eng. Chem., vol. 13, no. 1, Jan. 1921, pp. 26–31. Comparison of by-product and beehive ovens.

COKE OVENS

By-Product. By-Product Coke Oven Plants of Yesterday and Today, J. M. Hastings, Jr. Coal Industry, vol. 4, no. 1, Jan. 1921, pp. 44–47, 6 figs. Progress of art in 28 years as illustrated by old and new plants of Semet-Solvay Co.

Jones and Laughlin New By-Products Plant. Coal Industry, vol. 4, no. 1, Jan. 1921, pp. 47–51, 1 fig. Plant consists of five batteries of 60 ovens each of Koppers crossed regenerative type.

The By-Product Coke Oven Industry, 1920, D. J. Ramsburg. Coal Industry, vol. 4, no. 1, Jan. 1921, p. 52. First large battery of triangular flue type ovens completed and successfully operated during year.

COMBUSTION

CO_2 Recorders. The Unograph—An Automatic Continuous Analyzer without Chemical Absorption (L'"Unographe," analyseur continu et automatique sans absorption chimique), J. Izart. Chaleur et Industrie, no. 7, Oct. 1920, pp. 433–435, 3 figs. Principle and operation of Dommer CO_2 recorder.

CONCRETE, REINFORCED

Bond Resistance. Tests of Bond Resistance Between Concrete and Steel, W. A. Slater, F. E. Richart and G. G. Scofield. Technologic Papers, Bur. of Standards, no. 173, Nov. 1, 1920, 66 pp., 79 figs. Results of three dissimilar investigations which were made by concrete ship section of Emergency Fleet Corporation. One investigation was made to study effect on bond resistance of applications of various anticorrosive coatings on reinforcement; second investigation was made to study length of lap required for effective splicing of reinforcing bars in regions of high tensile stress; third investigation was made to study relative merits of different methods of anchoring ends of stirrups to meet certain conditions which arise in concrete ship construction.

CONDENSERS, STEAM

Naval Uses. Service Experience with Condensers, G. B. Allen. Power, vol. 52, no. 23, Dec. 7, 1920, pp. 914–916, 2 figs. Experience of British Admiralty. (Abstract.) Paper read before Inst. of Metals.

CONTRACTS

Cost-Plus. Cost-Plus Contracts, J. C. Keith. Jl. Eng. Inst. Canada, vol. 4, no. 1, Jan. 1921, pp. 8–11. Explanation of differences between cost-plus and unit-price form of contract, advantages and disadvantages, with examples of contracts on cost-plus basis.

CONVEYORS

Belt. General Types of Belt Conveyors, S. C. DeWitt. Can. Manufacturer, vol. 41, no. 1, Jan. 1921, pp. 62–64, 5 figs. Suitability of various types for different materials.

Factories. Conveyance in Workshop (Werkstättentransporte). Betrieb, vol. 3, no. 5, Dec. 10, 1920, pp. 37–38. Preliminary program prepared by the Committee for Economic Production dealing with following subjects: Determination of fundamental principles for economical use; establishment of useful sphere of hand and motor conveyors; adaptation of conveyor to its particular useful sphere, etc.

Foundry. Foundry Conveyor Equipment Offers Ideas for Adaptation Elsewhere, Norman G. Shidle. Automotive Industries, vol. 43, no. 26, Dec. 23, 1920, pp. 1274–1277, 9 figs. Methods of handling castings and other materials by means of various types of conveyors in foundry of Hercules Gas Engine Co.

Gravity. The Gravity Conveying System, L. T. Sylvester. Can. Manufacturer, vol. 41, no. 1, Jan. 1921, pp. 70–71, 9 figs. Typical installation.

Installations. A Highly Efficient Conveying Plant (Eine Förderanlage von hoher Wirtschaftlichkeit), G. Schlesinger. Zeit. des Vereines deutscher Ingenieure, vol. 64, no. 46, Nov. 13, 1920, pp. 949–953, 21 figs. Details of a mechanical hauling arrangement by means of which loading and unloading work at a drying plant for rifle stocks formerly requiring more than a hundred men can be carried out by two men. Notes on arrangement and manipulation of special cages and description of the drying plant.

COPPER METALLURGY

Smelter Stacks. See CHIMNEYS.

CORES

British Foundry Practice. Core Making Practice In Britain. Foundry, vol. 49, no. 2, Jan. 15, 1921, pp. 69–71, 9 figs. Cores employed to form exterior as well as interior of castings are recognized as economical factor in reducing cost of molding.

COST ACCOUNTING

Charts. How Graphics Help in Estimating Costs, J. B. Carr. Indus. Management, vol. 61, no. 1, Jan. 1, 1921, pp. 41–44, 4 figs. Method is illustrated by applying it to determine cost of Scotch boilers of various styles and sizes.

Making Statistics Talk—II, M. C. Rorty. Indus. Management, vol. 61, no. 1, Jan. 1, 1921, pp. 45–50, 13 figs. Exemplifies values and importance of charts in cost accounting.

Comparative Records. Comparative Cost Records as an Aid to Manufacturing Profits, Stephen R. Gordon. Indus. Management, vol. 61, no. 1, Jan. 1, 1921, pp. 17–22, 13 figs. How attention to details, such as decreasing waste in cutting cloth in textile mill and irregular stretching in dye house effected savings of more than $16,000 a year.

Overhead Expense. Machine-Hour Rate Method of Distributing Manufacturing Expense, C. Haigh. Machy. (N. Y.), vol. 27, no. 4, Dec. 1920, pp. 370–372. Comparison of man-rate and machine-hour rate method of considering overhead expense. Paper read before Am. Gear Manufacturers' Assn.

COTTON

Finishing Plants. Power Applications to Cotton-Finishing Plants, Leo Loeb. Mech. Eng., vol. 43, no. 1, Jan. 1921, pp. 5–8, 7 figs. Generation of power and of steam and applications to driving of process machinery are traced from boilers to motor applications. Charts are presented showing steam consumption and proportion of exhaust steam converted into work and available at exhaust for different types of prime movers. Illustrations of typical drives are included.

CRANES

I-Beam Girders. Properties of Crane Girder Sections, John H. Sawkins. Eng. News-Rec., vol. 86, no. 1, Jan. 6, 1921, p. 13, 2 figs. Table of mechanical properties of I-beam crane girders with lateral stiffening channels.

Long-Span. A New Form of Long-Span Crane. Engr. vol. 130, no. 3391, Dec. 24, 1920, pp. 631–632, 5 figs. General feature is that although crane has overhead girder spanning site of its operations, load is not carried directly by this girder, but by cableway attached to its two ends.

Pontoon. Huge Pontoon Crane. Pacific Mar. Rev., vol. 18, no. 1, Jan. 1921, pp. 30–31, 3 figs. Self-propelled 200-ton pontoon crane built by A. F. Smulders Corp., Holland.

Ship. A 250-Ton Ship Crane for the United States Navy, A. F. Case. Pacific Mar. Rev., vol. 18, no. 1, Jan. 1921, pp. 29–30, 4 figs. Revolving crane to be mounted on hull of U. S. Battleship Kearsarge.

CUTTING TOOLS

Construction. Metal Cutting Tools, A. L. De Leeuw. Am. Mach., vol. 54, no. 1, Jan. 6, 1921, pp. 1–7, 21 figs. Analogy between actions of razor, hatchet and metal cutting tools. Formation of chips. Elementary considerations in construction of simple tools.

Grinding. Grinding Lathe and Planer Tools. Machy. (Lond.), vol. 17, no. 432, Jan. 6, 1921, pp. 418–420, 2 figs. correct angle to use when grinding. Power consumption for different angles and position of lathe tools.

Inserted Cutters. The "Herbert" Patent High Duty Inserted Tooth Face Cutter. Practical Engr., vol. 62, no. 1766, Dec. 30, 1920, pp. 420–422, 5 figs. Invention is applicable to milling cutters, boring bars and generally wherever body of tool may be made of softer steel than that of tooth.

Screw Threads. Spring Tool for Cutting Threads. Iron Age, vol. 107, no. 3, Jan. 20, 1921, p. 208, 1 fig. Tool utilizes goose-neck principle to eliminate chatter and permit cutting of smooth threads on lathe work.

CYLINDERS

Castings. Make Marine Cylinders in New Shop, Herbert R. Simonds. Foundry, vol. 49, no. 1, Jan. 1, 1921, pp. 1–4, 7 figs. Making of castings at Boston Navy Yard.

Manufacture. Cylinder Blocks Manufactured in an Efficient Manner, J. Edward Schipper. Automotive Industries, vol. 44, no. 2, Jan. 13, 1921, pp. 72–77, 14 figs. Manufacturing process used in machining cylinder block castings for Lexington car.

D

DIES

Compound. Compound Blanking, Forming and Piercing Die, F. H. LeJeune. Machy. (N. Y.), vol. 27, No. 5, Jan. 1921, pp. 441–442, 3 figs. Die for producing tractor-wheel spoke covering one operation.

Locomotive Parts. Special Railroad Machine Forging Tools, J. V. Hunter. Am. Mach., vol 54, no. 2, Jan. 13, 1921, pp. 67–68, 7 figs. Description of dies used for forging locomotive grease cups, universal-joint jaws, connecting rods, valve handles, boiler-flue beading tools, etc.

Seamless Kettles. Drawing Operations on Seamless Kettles, Fred R. Daniels. Machy. (N. Y.), vol 27, no. 5, Jan. 1921, pp. 433–437, 18 figs. Design of dies and step-by-step operations in making difficult drawn shape.

DIESEL ENGINES

Diesel-Sulzer. Diesel-Sulzer Two-Cycle Motor Exhibited at Crystal Palace Great War Exhibition in London (Moteur Diesel-Sulzer à deux temps, au Great War Exhibition du Crystal Palace, à Londres). Bulletin technique de la Suisse romande, vol. 46, no. 23, Nov. 13, 1920, pp. 265–267, 4 figs. Effective power is 425 hp. at speed of 200 r.p.m.; fuel consumption varies from 195 to 200 grams per effective horse-power-hour. Engine is directly reversible.

Doxford. The Doxford Diesel Engine. Eng., vol. 110, no. 2869, Dec. 24, 1920, pp. 838 and 845–846, 2 figs. Opposed piston solid injection two-cycle reversible marine oil engine.

German Submarine. Modern German Submarine Diesel Engines (Neuere deutsche Unterseeboots-Dieselmaschinen), Max Wilh. Gerhards. Motorwagen, vol. 23, no. 27, Sept. 30, 1920, pp. 512–519, 8 figs. Details and data of construction and operation of different types of submarine oil engines built by the Machine Factory Augsburg-Nürnberg (M. A. N.).

Solid-Injection. The Solid Injection Engine, C. McTaminey. Trans. Inst. Mar. Engrs., vol. 32, Nov. 1920, pp. 161–178 and (discussion) pp. 179–194, 4 figs. Details of construction of Diesel marine installations developed by British Admiralty during war.

DOCKS

Testing U-Boats. German Marine Testing Dock (Prüfdock für die Deutsche Marine), H. Klitzing. Zeit. des Vereines deutscher Ingenieure, vol. 64, no. 51, Dec. 18, 1920, pp. 1074–1079, 19 figs. Dock built 1916–1918 for testing U-boats consists of a supporting pontoon, side compartments for insuring position of equilibrium, and a 116-m. pressure cylinder for housing of test boat, which has internal diameter of 12 m.; on both sides of the freely mounted pressure cylinder is room for docking two additional boats. Description of entrance shaft to test boat, manholes of pressure cylinder, pump plant, etc.

DRILLING MACHINES

Automatic. Automatic Drilling Machine with Gravity Feed. (Machy. Lond.), vol. 17, no. 431, Dec. 30, 1920, pp. 396–397, 2 figs. Each of two spindles operates independently, and feeding of drill into work is accomplished by weight which exerts constant feeding pressure during drilling operation.

Radial. Large Radial Drilling Machines. Eng. Production, vol. 2, no. 14, Jan. 6, 1921, pp. 22–23, 1 fig. Designed for use on large turbine work.

DRILLS

Twist. Helix Angle of Twist Drills, Bruce W. Benedict. Am. Mach., vol. 53, no. 26, Dec. 23, 1920, pp. 1175–1178, 5 figs. Concludes from experiments that with present design of flute, most efficient high-speed milled twist drill has helix angle of 35

deg., and that drill with this angle has greater endurance than drills of other helix angles.

DUST

Action, Theory of. Theory of Dust Action, O. W. Armspach. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 26, no. 9, Dec. 1920, pp. 819–829, 6 figs. Report upon investigations carried out jointly by Research Bureau & U. S. Bureau of Mines. It is shown that dust content in room depends upon density of material, velocity of fall of particles and size of room; dust will accumulate until definite content is reached depending upon rate of fall and number of air changes.

DYNAMOMETERS

Variable-Speed. A Variable Speed Fan Dynamometer, Karl D. Wood. Aerial Age, vol. 12, no. 19, Jan. 17, 1921, pp. 491–492, 4 figs. Apparatus designed by automotive power-plant section of Bureau of Standards.

E

ECONOMIZERS

Installation. Economizers, W. F. Wurster. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 26, no. 9, Dec. 1920, pp. 811–818, 6 figs. Typical installations of economizers in steam power plants.

Operation. Two Useful Suggestions in Regard to Operation of Economizers (Deux points utiles à connaître concernant les économiseurs), Henry Dieterlen. Chaleur & Industrie, no. 8, Nov.-Dec. 1920, pp. 487–489, 3 figs. How to prevent trouble in pumps arising from hot water used, and how to prevent vapor condensation on outside of economizer.

EDUCATION, INDUSTRIAL

Coöperative High-School Course. The Industrial Coöperative Course of the Lansing High School, E. M. Hall. Am. Mach., vol. 54, no. 3, Jan. 20, 1921, pp. 83–86, 13 figs. Course, open to youths of city of Lansing, intended to provide thorough training and experience in technical trades.

[See also VOCATIONAL EDUCATION.]

ELECTRIC DRIVE

Refrigerating Plants. Electric Drive for Ice Making and Refrigerating Plants, William J. Bray. Ice & Refrigeration, vol. 60, no. 1, Jan. 1921, pp. 23–25, 3 figs. Types of apparatus.

[See also ROLLING MILLS, Electrically Driven.]

ELECTRIC FURNACES

Annealing. Electric Annealing and Heat Treating Furnaces, George P. Mills. Jl. Engrs. Club of Phila., vol. 38–1, no. 193, Jan. 1921, pp. 25–31, 6 figs. Ni-chrome resistor type of electric furnace. Operating data on typical installations and probable trend of new applications.

Brass. New Casting Shop of the Bridgeport Brass Company, H. M. Lane. Metal Industry (N. Y.), vol. 19, no. 1, Jan. 1921, pp. 1–3, 5 figs. Construction and method of operation of shop running entirely on electric furnaces.

Booth Rotating. Booth Rotating Electric Brass Furnace. Metal Industry (Lond.), vol. 17, no. 26, Dec. 24, 1920, pp. 507–508. Features of later designs. Automatic electrode control.

Iron-Smelting. Swedish Electric Pig Iron Furnaces, Jonas Herlenius. Chem. & Metallurgical Eng., vol. 24, no. 3, Jan. 19, 1921, pp. 108–112, 3 figs. Description of Swedish electric furnace and summary of results obtained from its use.

Refractories for. Refractories for Electric Furnace, R. M. Howe. Chem. & Metallurgical Eng., vol. 23, no. 25, Dec. 22, 1920, pp. 1215–1218. Description of properties of refractory brick and of raw materials employed in their manufacture, with review of many factors involved in efficient use of refractories in general. Paper read before Elec. Furnace Assn.

Synthetic Pig Iron. See PIG IRON, Synthetic.

Uses. Electric Furnace Usage Fast Increasing. Elec. World, vol. 77, no. 2, Jan. 8, 1921, pp. 77–79, 3 figs. More than 220 non-ferrous furnaces installed during 1920. Total connected furnace load estimated at 880,000 kva., of which 410,000 kva. is in commercial furnaces. Electric steel output reduced.

ELECTRIC LOCOMOTIVES

C. M. & St. P. New Electric Passenger Locomotives in Operation on the C. M. & St. P. Railway, W. H. Munn. Jl. Western Soc. Engrs., vol. 26, no. 1, Jan. 1921, pp. 26–29, 2 figs. Characteristics: Total weight, 275 tons; number of driving axles, 6; classification, 4–6–2–2–6–4; tractive effort, continuous rating, 49,000 lb.; speed maximum, 65 m.p.h.

Switzerland. The Locomotives of the Swiss Railways (Les locomotives des chemins de fer rhetiques), Lucien Pahin. Revue générale de l'Électricité, vol. 8, no. 25, Dec. 18, 1920, pp. 872–878, 8 figs. Details of electric locomotives of Brown Boveri & Co.

ELECTRIC PLANTS

Interconnection. Coöperation for the Central Station and Isolated Plant. Elec. World, vol. 77, no. 1, Jan. 1, 1921, p. 11. Interconnection is economically sound and is shown to hold mutual advantages where isolated plants can be justified.

ELECTRIC WELDING, ARC

Boiler Repairing. The Electric Welding of a Corroded Boiler-Shell, A. Kenneth Dawson. Trans. Instn. Min. Engrs., vol. 60, part 1, Nov. 1920, pp. 8–12, 3 figs. Repairing of corroded colliery Lancashire boiler by use of portable electric-arc welding apparatus.

Car-Truck Frame. Arc Welding on Railway Properties, A. M. Candy. Elec. Ry. Jl., vol. 57, no. 3, Jan. 15, 1921, pp. 121–124, 17 figs. Truck frames manufactured by Government Electric Railways of Sydney, Australia, and other examples of applications of electric welding in manufacture of railway cars.

Equipment. Electric Welding, William T. Bonner, A. A. Nims, C. J. Holslag and H. E. Dralle. Jl. Engrs. Club of Phila., vol. 38–1, no. 193, Jan. 1921, pp. 7–23, 8 figs. Notes on selection of arc-welding equipment and fundamentals of its efficient operation.

Practice. Arc Welding Practice. J. H. Anderton. Jl. Elec., vol. 45, no. 12, Dec. 15, 1920, pp. 572–574. Greater flexibility and better control in arc welding are obtained by use of metal instead of carbon electrode. Records of tensile tests of welds are included.

The Welding of Metals by the Electric Arc (La soudure des différents métaux par l'arc électrique), Ch. Andry-Bourgeois. Électricien, vol. 51, no. 1266, Dec. 15, 1920, pp. 536–539, 1 fig. Welding of bronzes and aluminum alloys. (Continuation of serial.)

Steel. Electric-Arc Welding of Steel: I. Properties of the Arc-Fused Metal, Henry S. Rawdon, Edward C. Groesbeck and Louis Jordan. Technologic Papers, Bur. of Standards, no. 179, Nov. 15, 1920, 63 pp. 28 figs. Research to determine in empirical way by actual welding tests carried out by skilled operators relative values and merits of different types of electrodes which are available commercially.

ELECTRICAL INDUSTRY

Developments in 1920. Some Developments in the Electrical Industry During 1920, John Liston. Gen. Elec. Rev., vol. 24, no. 1, Jan. 1921, pp. 4–49, 99 figs. Developments in turbo-generators, electric locomotives, electrical machinery, electric cranes, hoists, transformers, insulators and electric lighting.

EMPLOYEES' REPRESENTATION

Shop Committees. A Shop Committee that Failed, O. F. Carpenter. Indus. Management, vol. 61, no. 1, Jan. 1, 1921, pp. 59–62. Experience of one firm that introduced industrial democracy.

Works Councils. Works Council after Two Years' Trial. Can. Machy., vol. 24, no. 27, Dec. 30, 1920, pp. 597–600, 6 figs. Experience of International Harvester Co.

EMPLOYMENT MANAGEMENT

Selecting Employees. Fewer Mistakes in Selecting Employees, William S. Dutton. Factory, vol. 26, no. 1, Jan. 1, 1921, pp. 38–39, 2 figs. Experiences of E. I. duPont de Nemours & Co.

ENGINEERING SOCIETIES

Progress in 1920. Progress of Engineering Societies in 1920, Calvin W. Rice. Power, vol. 53, no. 1, Jan. 4, 1921, pp. 22–23. Outstanding event is establishment of Federated American Engineering Societies which typifies "unselfish devotion on the part of the engineering profession to the good of the community and the nation."

ENGINEERS

Registration. Code of Practice and Schedule of Fees for Structural Engineers. Eng. & Contracting, vol. 54, no. 25, Dec. 22, 1920, pp. 603–605. Proposed code of practice for use of members of Structural Engineers' Association of Illinois prepared by committee of association.

Engineering Legislation for Ont. Contract Rec., vol. 35, no. 2, Jan. 12, 1921, pp. 39–44. Draft bill for registration of engineers, drawn up by Advisory Conference Committee representing civil, mechanical, electrical and mining engineers.

Engineering Legislation in Canada, Fraser S. Keith. Eng. News-Rec., vol. 86, no. 1, Jan. 6, 1921, pp. 21–24. Outline of history of movement for statutory control of professional practice, with synopsis of acts passed by provinces.

Saskatchewan's "Engineering Profession Act." Can. Engr., vol. 39, no. 25, Dec. 16, 1920, pp. 615–618. Text of bill that has been introduced in Saskatchewan Legislature.

Remuneration. Fees and Services of Practicing and Consulting Engineers, W. L. Benham. Eng. News-Rec., vol. 85, no. 27, Dec. 30, 1920, pp. 1266–1267. Report of Committee on fees and services of practicing engineers of American Association of Engineers.

The Engineering Profession and Government Technology, R. S. McBride. Chem. & Metallurgical Eng., vol. 23, no. 26, Dec. 29, 1920, pp. 1265–1267, 3 figs. Need for increasing salaries of government professional employees is brought out by enumeration of series of facts on conditions now existing in different government technical bureaus.

Social Functions. The Engineer's Service to Society, Fred J. Miller. Mech. Eng., vol. 43, no. 1, Jan. 1921, pp. 1–4 and 8. Discusses influence of engineer in constructive adjustment, property rights and human rights and relations between employer and employee. Presidential address at Annual Meeting of Am. Soc. Mech. Engrs.

ENGINEHOUSES

Design. Modernizing Locomotive Terminals, G. W. Rink. Mech. Eng., vol. 43, no. 1, Jan. 1921, pp. 13–16, 5 figs. Location, size and general layout of terminal are dependent on various elements, two principal factors being character of work to be performed and location of general locomotive repair shop. Necessity for providing modern facilities is discussed with a view of awakening an interest in this subject, which has important bearing on ability of railroads to handle increased traffic demands of country.

EXECUTIVES

Industrial. The Executive—and Today's Problem, Lewis E. Pierson. Indus. Management, vol. 61, no. 1, Jan. 1, 1921, pp. 7–8 and p. 50 and 57–58. Suggestions to executives in regard to present business conditions.

F

FACTORIES

Oversize Construction. Oversize Construction Plant Demonstrates Value. Eng. News-Rec., vol. 86, no. 2, Jan. 13, 1921, pp. 82–85, 4 figs. Automobile body factory at Cleveland, Ohio, completed in quick time by concentrating equipment for peak-load construction.

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT

FARM MACHINERY

Electrically Operated. Electric Farming (Le labourage électrique). Bulletin de la Société Française des électriciens, vol. 10, no. 86, Feb. 1920, pp. 57–78, 11 figs. Electric winch for operating plow, and other electrically operated machinery, together with portable transformer for taking power at various points of line.

London Show. The Smithfield Club Show. Engr., vol. 130, no. 3389, Dec. 10, 1920, pp. 582–583, 6 figs. Details of farm machinery exhibited at London Show.

FATIGUE

Blast-Furnace Men. Fatigue of Blast-Furnace Men. Iron & Coal Trades Rev., vol. 101, no. 2757, Dec. 31, 1920, pp. 910–911. Report issued by Committee of Industrial Fatigue Research Board, England.

FERROALLOYS

Iron-Vanadium. The Magnetizability of Iron-Vanadium Alloys (Die Magnetisierbarkeit von Eisen-Vanadium-Legierungen), R. Dieterle. Archiv. für Elektrotechnik, vol. 9, no. 7, Nov. 8, 1920, pp. 314–318, 2 figs. Results of author's measurements are presented in curves and tables, from which it is concluded that vanadium has the same effect as silicon and aluminum on the magnetic properties of iron and could, therefore, be taken into consideration for the production of so-called alloyed sheet metals.

FIRE PREVENTION

Pulpwood Piles. Fire Prevention in Pulp Wood Piles, F. J. Hoxie. Paper, vol. 27, no. 15, Dec. 15, 1920, pp. 13–19, 13 figs. Spray nozzles forming artificial fog for protection of piles of pulpwood.

FLIGHT

Soaring. Soaring Flight (Le vol a voile), P. Idrac. Nature (Paris), no. 2434, Nov. 27, 1920, pp. 347–349. Forces acting.

Soaring Flight (Sur le probleme du vol à voile), Jean Constantin. Aéronautique, vol. 2, no. 18, Nov.-Dec. 1920, pp. 251–255, 3 figs. Theory of forces acting. Support of bird is found to depend on resultant of mass on wings, action of wind against inclined plane of body and curved surface of wings, and greater inertia of moving air.

The Gliding and Soaring Flight Contest in the Rhön Mountains (Der Gleit- und Segelflug-Wettbewerb in der Rhön), Ferdinand Trendelenburg. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 11, no. 20, Oct. 30, 1920, pp. 295–297, 1 fig. Account of flights and details of aeroplanes figuring in contest. Report of the German Experimental Inst. for Aeronautics.

The Soaring Flight of Birds, Leon Bollee. Aerial Age, vol. 12, no. 16, Dec. 27, 1920, pp. 421, 5 figs. Study of forces acting.

FLOW OF AIR

Conduits. Measurement of Quantity of Air Flowing Through a Conduit (La mesure des débits de vent), M. Lebrasseur. Chaleur & Industrie, no. 8, Nov.-Dec. 1920, pp. 474–477, 5 figs. Measurement by means of venturi is preferred.

FLOW OF STEAM

See FLOW OF WATER, Transmission Wastes.

FLOW OF WATER

Concrete Pipe Lines. Flow of Water in Concrete Pipe Lines. Can. Engr., vol. 40, nos. 1 and 2, Jan. 6–13, 1921, pp. 101–105, 2 figs., and 124–126, 3 figs. Test data showing effect of variations in character and condition of pipe on coefficients of retardation for various formulæ. Test of big conduit at Niagara Falls.

Dredge Pipes. Velocity Tests in Hydraulic Dredge Pipe, Ivan E. Houk. Eng. News-Rec., vol. 86, no. 1, Jan. 6, 1921, pp. 18–19, 1 fig. Description of apparatus for measuring velocity of dredge pipe discharge, and tables of results obtained.

Transmission Wastes. Transmission Wastes. Power Plant Eng., vol. 25, no. 1, Jan. 1, 1921, pp. 85–93, 11 figs. Chart of flow of water in pipes and loss of head by friction, also for determining loss of steam pressure per 100 ft. of pipe.

FLUE-GAS ANALYSIS

Graphical Method. A Graphical Method for the Interpretation of Flue Gas Analyses, Gilbert B. Howarth. Jl. Soc. Chem. Industry, vol. 39, no. 24, Dec. 31, 1920, pp. 329T–333T, 3 figs. Construction of diagram and its use for commercial purposes.

FLYWHEELS

Stresses in. Resistance of a Disk Subjected to Rapid Rotation (De la résistance des disques à rotation rapide), L. Anspach. Bulletin technique de l' Association des Ingénieurs sortis de l'École Polytechnique de Bruxelles, vol. 14, no. 1, 1920–1921, pp. 21–54, 1 fig. Fundamental formula developed in general case and applied to design and study of flywheels.

FORGING

Brass. Making Brass Forgings. Machy. (Lond.), vol. 17, no. 430, Dec. 23, 1920, pp. 341–346, 10 figs. Methods developed by Mueller Metals Co. in metal working.

Furnaces. The Construction of Ducts for Forge Exhaust and Blast Systems. Heat. and Vent. Mag., vol. 17, no. 12, Dec. 1920, pp. 35–39, 8 figs. Furnace installation at plant of General Vehicle Co., Long Island City.

Steel. The Forging of Steel and Fundamental Principles for the Design of Steam and Drop Hammers (Das Schmieden des Stahls und die Grundlagen zur Bemessung von Hämmern und Fallwerken), Erich Siebel. Werkstattstechnik, vol. 14, nos. 18, 20 and 21, Sept. 15, Oct. 15 and Nov. 1, 1920, pp. 492–496, 529–532 and 566–569, 17 figs. After a brief discussion of metallurgical conditions in connection with forging and annealing, the machine equipment for hot forging is discussed. Investigation of the phenomena occurring with die forging and swaging, and especially of the relation between existing experimental results and operating experiences on one hand and the theoretical considerations on the other.

FOUNDRIES

Aluminum. Analyze Loss in Aluminum Shops—III, Robert J. Anderson. Foundry, vol. 49, no. 2, Jan. 15, 1921, pp. 54–57, 2 figs. Conditions at several typical foundries described, including melting equipment and operation molding methods and inspection routine. Pyrometric control varies in different foundries.

Conveying Equipment. See CONVEYORS, Foundry.

Layout. Foundry Planning by Example, Charles K. Sumner. Metal Trades, vol. 12, no. 1, Jan. 1921, pp. 14–15. Data on twelve existing gray iron foundries in San Francisco and vicinity.

Scrap Recovery. Economy in the Recovery of Scrap in Iron and Steel Foundries (Ueber die Wirtschaftlichkeit der Rückgewinnung des Abeisens in Eisen- und Stahlgiessereien), Hubert Hermanns. Betrieb, vol. 3, no. 3, Nov. 10, 1920, pp. 66–67, 1 fig. Includes tabular data compiled from four different plants showing net production costs of recovered scrap, and curves showing results of calculation of operating costs.

[See also CORES.]

FUELS

Briquets from Wastes. Manufacture of Briquets from Waste Fuels (Brikettierung von Abfallbrennstoffen), Otto Brandt. Betrieb, vol. 3, no. 3, Nov. 10, 1920, pp. 72–76, 5 figs. For making briquets from waste wood, tan bark and garbage a process which does not employ a binder is described, also one with a binder for making briquets from coke, coal, lignite, flue and smoke-box dust, slag residue, etc. Profitableness of such briquet plants for use of waste material is discussed.

Colloidal. Colloidal Fuel as Developed by the Submarine Defense Association of New York. Power Plant Eng., vol. 25, no. 1, Jan. 1, 1921, pp. 55–56, 2 figs. Chart giving comparative savings effected with colloidal fuel.

Colloidal Fuels, Their Preparation and Properties, S. E. Sheppard. Jl. Indus. & Eng. Chem. vol. 13, no. 1, Jan. 1921, pp. 37–47, 12 figs. Survey of developments.

Conservation. Fuel and its Conservation, L. P. Breckenridge, O. P. Hood, David Moffat Myers and Chester G. Gilbert and Joseph E. Pogue. Mech. Eng., vol. 43, no. 1, Jan. 1921, pp. 22–28 and (discussion) pp. 28–31 and 38. Group of papers dealing with fuel supply of world, fuel conservation, distillation of fuels, and form value of energy, with discussion thereon, which were presented at 1920 Annual Meeting of Am. Soc. Mech. Engrs.

Economical Use. Rational Utilization of Fuels (L'utilisation rationnelle des combustibles), Georges Charpy, Emilio Damour, E. De Loisy, M. Ader, Ch. Berthelot. Mémoires et Compte rendu des Travaux de la Société des Ingenieurs civils de France, vol. 73, nos. 4, 5 and 6, April-June, 1920, pp. 245–393. Symposium on fuel economy. Principles of economic composition of various fuels, gaseous, liquid and solid. Suggestions in regard to their economic utilization in industrial works.

Oil. See OIL FUEL.

Patented Mixtures. Improvements in Furnace Installations for Hard Fuels (Neuerungen an Feuerungsanlagen für feste Brennstoffe), A. Pradel. Feuerungstechnik, vol. 9, no. 2, Oct. 15, 1920, pp. 13–17, 10 figs. Quarter-yearly report describing new foreign and domestic patents and innovations.

Turf. A New Process of Drying Turf for Fuel in Finland. Commerce Reports, no. 306, Dec. 30, 1920, p. 1359. Raw turf in swamp is freed from old roots and changed to thin mud by powerful jet of water under pressure of 20 atmospheres. This is pumped out on drying field and spread in layers from 20 to 30 centimeters in depth. When dry it is cut into bricks of uniform size by means of tractor.

[See also LIGNITES; PEAT; PULVERIZED COAL.]

FURNACES, BOILER

Design. New Patents for Steam-Boiler Furnaces (Neue Patente auf dem Gebiete der Dampfkesselfeuerung), A. Pradel. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 43, nos. 40 and 42–43, Oct. 1 and 22, 1920, pp. 305–310 and 323–326, 34 figs. Quarter-yearly report giving review of recently patented foreign and domestic devices.

Forced-Draft. Forced-Draft Furnaces (Unterwindfeuerungen), L. Schmitt. Zeit. des Verbandes Deutscher Diplom-Ingenieure, vol. 11, no. 17–18, Sept. 1–15, 1920, pp. 91–92. Information concerning operating costs of different types of undergrate blowers.

Lignite-Burning. The Adaptation of Steam-Boiler Furnaces to the Burning of Lignite (Umstellung von Dampfkesselfeuerungen auf Braunkohle), H. Berner. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 43, no. 42–43, Oct. 22, 1920, pp. 321–322. Points out advantages and disadvantages of the forced-draft horizontal grate.

Low-Grade Fuels. The Adaptation of Steam-Boiler Furnaces to Low-Grade Fuels (Die Umstellung der Dampfkesselfeuerungen auf minoerwertige Brennstoffe). Zeit. des Vereines deutscher Ingenieure, vol. 64, no. 51, Dec. 18, 1920, pp. 1069–1070. Full report published by the Board of Heat Conservation giving experiences recorded at the convention of Board in Berlin, September, 1920.

Stephens. Grateless, Smokeless, Automatic Furnace for Steam Power Production at the Mines. Coal Industry, vol. 4, no. 1, Jan. 1921, pp. 19, 1 fig. Patented process tested at Stephens laboratory, U. S. Bureau of Mines, Pittsburgh.

FURNACES, OPEN HEARTH

Waste-Heat Boilers. Application of Waste Heat Boilers to Open Hearth Furnaces, Thomas R. Tate. Assn. Iron & Steel Elec. Engrs., vol. 2, no. 12, Dec. 1920, pp. 1–6 and (discussion) pp. 6–10. Method of determining proper size and type boiler for any installation.

G

GAGES

Checking. Keeping an Accurate Check on Gages, J. Edward Schipper. Automotive Industries, vol. 43, no. 25, Dec. 16, 1920, pp. 1225–1227, 7 figs. Method of checking gages at plant of Lincoln Motor Co.

Measurement of. Two Apparatus for the Measurement of Threads and Gages (Zwei Apparate zur Messung von Gewinden und Lehren), F. Göpel. Werkstattstechnik, vol. 14, no. 21, Nov. 1, 1920, pp. 559–563, 15 figs. Description of a measuring machine with spirit-level gage for determination of pitch of thread; and an angle meter for chasing tools based on principle of the goniometer. Both instruments designed by author.

GAS ENGINES

Blast-Furnace Gas. Cockerill Blast-Furnace Gas Engines, H. Hubert. Engr., vol. 130, no. 3386, Nov. 19, 1920, pp. 495–498, 11 figs. Performance tests.

Design. Recent Improvements in Large Gas Engines (Les derniers perfectionnements aux moteurs à gaz de grande puissance), H. Feron. Vie technique & industrielle, vol. 2, no. 13, Oct. 1920, pp. 14–17, 7 figs. Design of special fixtures and attachments for gas engines of more than 1000 hp.

Vertical. 120 H. P. Vertical Gas Engine. Engr., vol. 130, no. 3388, Dec. 3, 1920, p. 567, 2 figs. Three-crank vertical engine with one cylinder, 13-in. bore and 14-in. stroke for each crank, and capable of giving constant output of 120 b.hp. on producer gas.

GASES

Volume Measurement. Methods of Measuring Large Volumes of Gases, specially Applicable to Gas and Coke Works (Méthods de mesure de grands volumes gazeux spécialement applicables aux usines à gaz et aux cokeries), M. C. Berthelot. Revue de Métallurgie, vol. 17, no. 10, Oct. 1920, pp. 668–676, 6 figs. Classification and comparison of practices in common use. Description of Nurgue volume-recording apparatus.

GASOLINE

Hecter Fuel. Comparison of Hecter Fuel with Export Aviation Gasoline, H. C. Dickinson, V. R. Gage and S. W. Sparrow. Nat. Advisory Committee for Aeronautics, report no. 90, 1920, 10 pp., 13 figs. Investigation conducted at altitude laboratory of Bureau of Standards. Hecter fuel is mixture of approximately 30 per cent benzol, 70 per cent cyclohexane by volume. For flight at low altitudes Hecter fuel showed slight advantages in comparison with gasoline by affording small increase of power over and above that necessary to offset disadvantage of increased fuel consumption. At 14,000 feet and 25,000 feet no appreciable difference in power was obtained, whereas fuel consumption of Hecter was greater to extent of 15 per cent by weight.

Natural Gas. Treating Natural-Gas Gasoline to Meet the "Doctor Test," D. B. Dow. Reports of Investigations, Bur. of Mines, Dept. of Interior, serial no. 2191, Dec. 1920, 4 pp. Basis for installation of economical treating process.

GASOLINE ENGINES

Exhaust Gases. Exhaust Gases of Petrol Engines. Times Eng. Supp., no. 554, Dec. 1920, p. 382. Methods of utilization.

Single Sleeve Valve. New Model of Single Sleeve Valve Engine. Automotive Industries, vol. 43, no. 26, Dec. 23, 1920, pp. 1270–1271, 2 figs. Burt-MacCullum engine manufactured by Argylls, Scotland, has been revived in improved and simplified form. Removable port liners used in cylinder. Valve is given combined oscillating and reciprocating motion. Heads are detachable.

Variable Clearance Volume. An Engine with Clearance Volume and Valve Timing Both Variable. Automotive Industries, vol. 43, no. 27, Dec. 30, 1920, pp. 1314–1315, 4 figs. Experimental engine has hydraulic device for raising and lowering crankshaft. Tests indicated considerable saving in fuel under normal operating conditions, but mechanical complications were involved.

GEARS

Bevel. Chordal Thickness of Tooth and Corrected Pitch Depth of Bevel Gears. Machy. (Lond.), vol. 17, no. 432, Jan. 6, 1921, pp. 423–424, 1 fig. Diagram showing dimensions and angles used in determining chordal thickness and corrected pitch depth of bevel gear teeth.

Horsepower Chart. Horsepower Chart for Gear Teeth. Machy. (Lond.), vol. 17, no. 430, Dec. 23, 1920, pp. 359–360, 1 fig. Chart for determining horsepower transmitted by gears when load is known.

Layout. Laying Out Gearing and Making Gear Patterns, H. J. M'Caslin. Can. Foundryman, vol. 12, no. 1, Jan. 1921, pp. 28–29, 3 figs. Study of gearing including spur, bevel and miter gears, involute and epicycloidal teeth, circular and diametral pitch and other features in connection with gearing.

Worm. The Efficiency of Worm-Gearing, W. S. Atkinson. Machy. (N. Y.), vol. 27, no. 4, Dec. 1920, pp. 315–316, 2 figs. Formula for computing efficiency in various cases.

GRINDING

Cylindrical. Work Speeds in Cylindrical Grinding, Robert J. Spence. Machy. (N. Y.), vol. 27, No. 5, Jan. 1921, pp. 438–440. Importance of instructing operators concerning proper work speeds to be used. Results obtained by reducing work speed.

Pulverizing Hard Materials. Progress in the Fine Grinding of Hard Material, III and IV (Neuerungen der Hartzerkleinerung), Carl Naske. Zeit. des Vereines deutscher Ingenieure, vol. 64, nos. 47 and 52, Nov. 20 and Dec. 25, 1920, pp. 980–985 and 1109–1113, 43 figs. Nov. 20: Discussion of kilns. Notes on revolving tubular kilns and utilization of waste heat; enlarged calcination zones; revolving tubular vs. shaft kilns; automatic shaft kilns; suggestions for automatic discharge devices; problems of fuel admission and mixture; a recommendation for burning of lime; Dec. 25: Description of plant for pulverizing castiron turnings for an analine factory; lime- and coke-crushing plant for a carbide factory; super-phosphate factory; plant for grinding and drying ammonium nitrate; lime-burning plant; soda-treatment plant; and portland-cement mill.

GRINDING MACHINES

Surface. Wilmarth & Morman Company's No. 78 Surface Grinding Machine. Am. Mach., vol. 54, no. 2, Jan. 13, 1921, pp. 41–42, 1 fig. Two precision screws used for adjusting wheel to cut. Clutch and all gears run in oil.

GUN METAL

Non-Corrodible. The Development of Non-Corrodible Gun Barrels. F. A. Fahrenwald. Monthly Bul. Can. Inst. Min. & Metallurgy, no. 105, Jan 1921, pp. 27–48, 2 figs. Objections to present-day gun steels are pointed out and materials for purpose are suggested.

GUNS

Manufacture. A Method of Gun Construction by Radial Expansion, S. J. Brown. United States Naval Inst. Proc., vol. 46, no. 214, Dec. 1920, pp. 1941–1970, 11 figs. Principle is that if hollow thick tube is exposed to internal pressure great enough to stress all fibers to elastic limit. When pressure is removed external layers will shrink back on internal layers and leave them in state of compression.

H

HARDENING

Fire Cracks. Fire Cracks and Some of Their Causes. J. V. Emmons. Metal Trades, vol. 12, no. 1, Jan. 1921, pp. 22–25, 9 figs. From "Metal Heating" published by Tate, Jones & Co., Inc., furnace engineers, Pittsburgh.

HEAT PUMPS

Utilization of. The Heat Economy and Useful Forms of the Heat Pump (Wärmewirtschaft und Anwendungsformen der "Wärmepumpe"), Gustav Flügel. Zeit. des Vereines deutscher Ingenieure, vol. 64, nos. 46 and 47, Nov. 13 and 20, 1920, pp. 954–958 and 986–989, 14 figs. Equations are presented for determining the heat economy of different concentration processes, both old and new, with special regard to utilization of the vapors given off and it is explained in what forms the heat pumps can be utilized for different purposes.

HEAT TRANSMISSION

Double Windows. The Transmission of Heat Through Single-Frame Double Windows, A. Norman Shaw. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 26, no. 9, Dec. 1920, pp. 773-786, 9 figs. In ten determinations in "3/4-in." and "1/2-in." single-frame double windows with external faces in contact with water it was found that all determinations were within five per cent of 1.25 b.t.u. per sq. ft. per hour per deg. fahr. difference.

HEAT TREATING

Industrial Applications. Industrial Applications of Heat Treating (Les traitements thermiques dans leur application actuelle), Arnould De Grey. Chaleur et Industrie, no. 7, Oct. 1920, pp. 419-428, 1 fig. Recent progress in tempering and hardening processes.

Thermal Analysis. Industrial Apparatus for Thermal Analysis in Heat Treating (Appareil industriel d'analyse thermique), M. Pierre Chevenard. Revue de Métallurgie, vol. 17, no. 10, Oct. 1920, pp. 687-695, 8 figs. Apparatus registers, in terms of time, temperature of sample submitted to regular heat-treating process and then left to itself to cool.

HEATING AND VENTILATION

Museums. The Heating and Ventilation of Museums (Die Beheizung, Luftzu- und abfuhrung und Luftbefeuchtung der Museen), H. Hasak. Gesundheits-Ingenieur, vol. 43, no. 43, Oct. 23, 1920, pp. 508-510. Writer describes system planned by him and adopted by the Kaiser-Wilhelm Museum in Berlin, Germany, where it has given great satisfaction, with regard to uniform heating, removal of dust from air, supplying moisture to air, etc.

Paper-Machine Rooms. Heating and Ventilation of Paper Machine Rooms, Edward A. Ryan. Jl. Eng. Inst. Canada, vol. 4, no. 1, Jan. 1921, pp. 21-27 and (discussion) pp. 28-31, 7 figs. Analysis of heating and ventilation problem for paper machine room, need for adequate ventilation to remove moisture and description of systems in use and proposed.

HELICOPTERS

Problem of. The Problem of the Helicopter. Aeronautical Jl., vol. 25, no. 121, Jan. 1921, pp. 3-19, 10 figs. Probable characteristics of first type of helicopter which will be constructed.

HYDRAULIC TURBINES

Manufacture. Machining Large Water Turbines, Fred H. Colvin. Am. Mach., vol. 53, no. 27, Dec. 30, 1920, pp. 1234-1236, 5 figs. Examples of turbine work at shop of Pelton Water Wheel Co., San Francisco.

HYDRODYNAMICS

Vortices in Liquids. Motion of Liquids (Sur le mouvement permanent des liquides), L. Lecornu. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 19, Nov. 8, 1920, pp. 881-885. Equations of vortex motion.

HYDROELECTRIC PLANTS

California. Forward Steps in California Hydro-Electric Designs. Eng. News-Rec., vol. 85, no. 27, Dec. 30, 1920, pp. 1260-1262, 3 figs. Unusual features include 200,000-volt transmission lines and larger units and higher reaction-turbine heads than have previously been used.

Chile. Braden Copper Company's Power System in Chile. Power, vol. 52, no. 19, Nov. 9, 1920, pp. 730-734, 8 figs. Two hydroelectric plants supply power to copper mines. One 22,500-kw. plant operated under 1550-ft. head. Other plant, 15,000 kw., operates under 440-ft. head.

Ejector Sluice Valves. The Action of Ejector Sluice Valves (Die Wirkung von Ejektorenschützen), H. Krey. Zentralblatt der Bauverwaltung, vol. 40, no. 75, Sept. 18, 1920, pp. 472-473, 2 figs. As result of observation that the tailwater from water-power plants is lowered through the waste water flowing over dam, whereby the output of turbine is increased, the idea was conceived to utilize this water for increasing the water power by use of so-called ejector sluices which by their suction act to increase head on turbine. In present article writer attempts to calculate increase of head attainable in order to ascertain feasibility and manner of plant required.

France. Hydroelectric Project for Complete Utilization of water Power in Allier Valley (Aménagement hydraulique intégral de la vallée de l'Allier). Revue générale de l'Électricité, vol. 8, no. 26, Dec. 25, 1920, pp. 907-915, 10 figs. Study for utilization of water power. From report submitted by various official committees.

The Hydroelectric Plants at Louron (Usines hydroelectriques du Louron), Marcel Waternaux, Revue générale de l'Électricité, vol. 8, no. 22, Nov. 27, 1920, pp. 765-778, 20 figs. Description of plants and details of transmission lines. Energy is transmitted at 125,000 volts.

5000-ft. Head. A 5000-Ft. Head Hydro-Electric Plant. Eng., vol. 110, no. 2869, Dec. 24, 1920, pp. 823-826, 7 figs. Installation at Fully, Switzerland. Generating station contains four sets each of 3000 hp., which run at 500 r.p.m., the Pelton wheels each having single jet which strikes wheel horizontally at its lowest point.

Lock Operation. The Influence of Lock Operation on the Hydroelectric Plants on the Canalized Neckar River (Der Einfluss der Schiffschleusungen auf die Wasserkraftanlagen an dem zu kanalisierenden Neckar.) Zentralblatt der Bauverwaltung, vol. 40, no. 77, Sept. 25, 1920, pp. 485-490, 7 figs. Gives results of locking experiments in the supply channel of the municipal electric power station in Poppenweiler, from which it is concluded that an interruption of operation of power station through navigation of canal need not take place providing proper measures are carried out with regard to requirements of navigation.

Low-Head. Developing the Low-Head Plant, Louis E. Ayres. Elec. World, vol. 76, no. 26, Dec. 25, 1920, pp. 1260-1263, 4 figs. Rehabilitation of old plants by installing hydraucones with high-speed runner. Gain in efficiency should be at least 25 per cent. Comparison of hydraucone with stream line draft tube.

Niagara Falls Power Development. Switch and Control Equipment at Niagara Falls, Stephen Q. Hayes. Elec. Rev. (Chicago), vol. 78, no. 2, Jan. 8, 1921, pp. 47-53, 10 figs. Precautions taken to guard generating apparatus. Indicating devices and instruments important factors in station operation. Switchgear for main generating units housed in substation. (To be continued.)

Scotland. The Inshes Hydro-Electric Installation, Elec. Rev. (Lond.), vol. 87, no. 2248, Dec. 24, 1920, pp. 803-804, 6 figs. Details of 50-kw. hydroelectric scheme in Scotland.

I

ICE PLANTS

Motor-Driven. Motor-Driven Ice-Plants—Electrical Consumption per Ton of Ice, John E. Starr. Power, vol. 52, no. 19, Nov. 9, 1920, pp. 742-743, 1 fig. Under usual conditions of pressures, loads, temperatures and volumetric efficiency, 48.5 kw.-hr. per ton of ice is usual result.

See also ELECTRIC DRIVE, Refrigerating Plants.

INDUSTRIAL EFFICIENCY

Health. The Cult of the Sound Body, T. V. Davidson. Sci. Am. Monthly, vol. 3, no. 1, Jan. 1921, pp. 33-36, 12 figs. Apparatus employed in modern physiological laboratories to test physical development.

INDUSTRIAL MANAGEMENT

Drafting Department. The Industrial Organization of the Drafting Department (L'organisation industrielle du bureau de dessin), Danty-Lafrance. Vie Technique & Industrielle, vol. 2, no. 14, Nov. 1920, pp. 134-140, 7 figs. Suggestions in regard to adopting symbolic nomenclature, standardization of records, etc.

Employment Relations. Building Workman Morale by Advertising, Harry Botsford. Iron Age, vol. 107, No. 2, Jan. 13, 1921, pp. 131. Dodge Mfg. Co., manufacturers of pulleys and power transmission equipment, display their advertising literature on billboard to inspire workmen to make good tribute paid them in it.

Inspection. Inspection as an Aid to Planning, George S. Radford. Indus. Management, vol. 61, no. 1, Jan. 1, 1921, pp. 25-30. How central inspection regulates flow of work.

Production Systems. Assuring Continuous Production. Elec. World, vol. 77, no. 3, Jan. 15, 1921, pp. 144-146, 3 figs. Standards of inspection adopted in several large plants in connection with successful maintenance work based on long experience under industrial conditions.

Fixtures for Quantity Production of Truck Parts—II. Metal Trades, vol. 12, no. 1, Jan. 1921, pp. 5-10, 10 figs.

Increasing Production with Standard Equipment. Machy. (Lond.), vol. 17, nos. 430 and 431, Dec. 23 and 30, 1920, pp. 437-355 and 380-382, 8 figs. Comparison of output and manufacturing costs for specific drilling operation under varying conditions.

Organization for Economic Production (Organisatorische Massnahmen bei der Fertigungssparwirtschaft), E. Springorum. Betrieb, vol. 3, no. 3, Nov. 10, 1920, pp. 59-60. It is shown how, through systematic superintendence of material, saving can be effected.

The Character, Effect, Possibilities and Limitations of Industrial Specialization (Die industrielle Spezialisierung, Wesen, Wirkung, Durchfuhrungsmöglichkeiten und Grenzen), H. Döhne. Zeit. des Vereines deutscher Ingenieure, vol. 64, no. 45, Nov. 6, 1920, pp. 937-939. Review and discussion of report of investigations of Committee on Economic Production.

Purchasing Materials. Purchasing Records and System, Wilfred G. Astle. Elec. Traction, vol. 16, no. 12, Dec. 1920, pp. 941-945, 8 figs. Forms for keeping of records.

Routing Work. Handling and Routing Large Work. Machy. (N. Y.), vol. 27, no. 4, Dec. 1920, pp. 358-364, 17 figs. Methods employed by Manning, Maxwell & Moore, Inc., in Putnam Machine Works, Fitchburg, Mass., for routing of work through factory.

Time Study. See TIME STUDY.

INDUSTRIAL RELATIONS

Open Shop Movement in U. S. Government Demands Open Shop, T. C. Dickson. Iron Trade Rev., vol. 67, no. 26, Dec. 23, 1920, pp. 1734-1735. Refuses to deal with trade unions in operation of arsenals, though promoting shop committee system of representation. Commanding officer describes War Department's methods in dealing with labor problems. Paper read before National Founders' Assn.

The Open Shop and the Motives Back of It, Ralph E. Fox. Indus. Management, vol. 61, no. 1, Jan. 1, 1921, pp. 37-39. Theory of open shop is opportunity to produce in necessary quantities in order that all may have plenty. Motive that lies back of any industrial plan must eventually determine its right to existence.

Widespread Support of the Open Shop—II, James A. Emery. Iron Age, vol. 106, no. 26, Dec. 23, 1920, pp. 1675 and pp. 1710-1711. Review of events of recent years. Address delivered before National Founders' Assn.

Plans. Relations Between Employers and Employed. Monthly Labor Rev., vol. 11, no. 6, Dec. 1920, pp. 94-103. Portland, Oregon, plan of preventing labor disputes, and Rochester plan of industrial democracy.

INTERCHANGEABLE MANUFACTURE

Allowances. Designations for Allowances (Passungszeichen), C. Volk. Betrieb, vol. 3, no. 3, Nov. 10, 1920, pp. 41-43, 2 figs. Various such designations are shown in a table and chart, giving reasons for designation, advantages and disadvantages. Report of German Industry Committee on Standards.

Fit Allowances. A System of Fit Allowances, Sydney B. Austin. Machy. (Lond.), vol. 17, no. 431, Dec. 30, 1920, pp. 384-386, 3 figs. Curves showing relation of allowances for fits to various diameters. Comparison of theoretical curves with Brown & Sharpe system of fit allowances and with Newall Engineering Co.'s system of fits.

INTERNAL-COMBUSTION ENGINES

Accessories. Improvements in Construction of Internal-Combustion Engines (Neuerungen auf dem Gebiet der Verbrennungskraftmaschinen). Wirtschafts-Motor, no. 11, Nov. 1920, pp. 21-22, 7 figs. Describes starting handle patented by the Austrian Daimler Motor Corp'n which can be turned only within a certain angle; a joint between spark plug and cylinder patented by Marc Birkigt, Bois Colombes, France, for purpose of introducing a simpler and more effective packing than is now in use; and a new electric starting device patented by Louis Renault, Billancourt, France, in which the electro-magnet consists of two windings, one of fine and the other of large wire between which there is a contact for shutting off the current of starting motor.

Exhaust Gas Losses. A Meter for Measuring Heat Losses in Exhaust Gas (Ein Abgasverlustmesser als Hilfsmittel für die Feuerführung), Fr. Wiedemann. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 43, no. 44, Oct. 29, 1920, pp. 335-336, 2 figs. Consists of a resistance meter so connected that it indicates difference in temperature of thermometers measuring respectively temperature of stock gases for air and combustion.

Four-Stroke vs. Two-Stroke. Four-Stroke vs. Two-Stroke System for Marine Engines (Viertakt und Zweitakt beim Schiffsmotor), Max Wilhelm Gerhards. Motorwagen, vol. 23, no. 30, Oct. 31, 1920, pp. 567-572. Critical discussion of the relative merits of both systems.

Fuels. The Proper Selection of Fuel for the Oil Engine, Allen F. Brewer. Power, vol. 52, no. 25, Dec. 21, 1920, pp. 972-974. Comparative properties of typical oils.

[See also AEROPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; GAS ENGINES; GASOLINE ENGINES; OIL ENGINES; TRACTOR ENGINES.]

IRON

Metallography. The Practical Application of the Metallography of Iron (Die praktische Anwendung der Metallographie des Eisens), G. Berndt. Zeit. der Deutschen Gesellschaft für Mechanik u. Optik, nos. 13-14, 15-16, 17-18 and 19-20, July 15, Aug. 15, Sept. 15 and Oct. 15, 1920, pp. 73-78, 86-91, 98-103 and 109-114, 31 figs. Notes on thermal analysis for determining the relation of different portions of texture appearing in iron and other metals. Various examples are given of solution in liquid and solid state. Photomicrographs. Report from the mechanical laboratory of the C. P. Goerz Optical Works.

IRON CASTINGS

Fluid Pressure in Molds. Pressure Due to Fluid Iron in Moulds, C. Webster. Mech. World, vol. 68, no. 1772, Dec. 17, 1920, pp. 442-443, 16 figs. Influence of pressure of fluid iron in straining, bursting and lifting of molds.

IRON METALLURGY

Control of Mixtures. Chemist Controls All Iron Mixtures. Foundry, vol. 49, no. 2, Jan. 15, 1921, pp. 59-62, 5 figs. Melting department in foundry of large plant with diversified output regulated by laboratory. Inclined skip hoist charges cupola.

Elements in Iron Control Mixtures, Fletcher Collins. Foundry, vol. 49, no. 2, Jan. 15, 1921, pp. 64-65. Hardness of cast iron mainly determined by state of carbon which is controlled by other elements. Silicon tends to free carbon and sulphur to hold it in combination.

K

KEYWAYS

Depth. Computing the Depth of Keyway inGear and Pulley Hubs, Henry R. Bowman. Am. Mach., vol. 54, no. 2, Jan. 13, 1921, p. 69. Formula.

L

LABOR

Child. Child Labor. Monthly Labor Rev., vol. 11, no. 6, Dec. 1920, pp. 126–131. Industrial instability of child workers in Connecticut.

LATHES

Zimmermann Automatic. The Zimmermann Automatic Lathe for the Rounding of Gear-Tooth Edges (Der Zimmermann-Zahnkanten-Abrund-Automat). Der praktische Maschinen-Konstrukteur, vol. 53, no. 44, Nov. 4, 1920, pp. 189–192, 10 figs. Machine for rounding off ends of gear teeth by means of an end mill, and rounding off automatically pinions up to 400 mm. diam.

LIGHTING

Direct vs. Diffused Light. Pleasing Proportions of Direct and Diffused Light from a Floor Lamp, J. R. Cravath. Trans. Illuminating Eng. Soc., vol. 15, no. 9, Dec. 30, 1920, pp. 631–644, 6 figs. Results of tests to determine pleasing proportions of direct and diffuse light from floor lamp under certain specified conditions.

Industrial. Significant Developments in Illumination During 1920, Preston S. Millar. Elec. World, vol. 77, no. 2, Jan. 8, 1921, pp. 82–85, 6 figs. Types of industrial lighting. Survey of progress in automobile headlight design.

Reflectors. The Standardization of Reflectors for Industrial Lighting. Illuminating Engr., vol. 13, no. 9, Sept. 1920, pp. 253–254, 2 figs. Photometric device for comparing efficiency of reflectors.

LIGNITE

Briquets. Lignite Bricks Pave Canada's Way to Fuel Independence, Walter Noble Burns. Coal Age, vol. 19, no. 2, Jan. 13, 1921, pp. 65–66, 1 fig. Lignite utilization board to place briquets on market. If they prove commercial success 300 new plants will be erected.

Canadian. Carbonization of Canadian Lignite, Edgar Stansfield. Jl. Indus. & Eng. Chem., vol. 13, no. 1, Jan. 1921, pp. 17–23, 4 figs. Laboratory tests by chemical staff of Fuel Testing Division of Mines Branch, Department of Mines, Ottawa.

LOCOMOTIVES

Auxiliary Tractor. Development of the Locomotive Auxiliary Tractor, J. Snowden Bell. Ry. & Locomotive Eng., vol. 34, no. 1, Jan. 1921, pp. 19–21, 5 figs. Survey of patented devices.

Axle Pressure. Axle-Pressure Variations in Locomotives Due to the Tractive Effort Exerted (Achsdruckänderungen bei Lokomotiven durch die ausgeübte Zugkraft), Paul Ritter. Annalen für Gewerbe u. Bauwesen, vol. 87, no. 6, Sept. 15, 1920, pp. 47–48, 2 figs. Examples are given showing change brought about in axle pressure distribution by tractive effort exerted; increase in many cases amounts to 15 per cent and in some cases to 25 per cent.

British. British Locomotive Progress. Railroad Herald, vol. 25, no. 1, Dec. 1920, pp. 16–18, 1 fig. Three-cylinder engine has become standard on one road. Large articulated compound engine not yet used. Superheaters increase.

Bureau of Locomotive Inspection. Report of the Bureau of Locomotive Inspection. Ry. Mech. Engr., vol. 95, no. 1, Jan. 1921, pp. 18–20, 4 figs. Application of water columns and other devices advocated; accidents increase in fiscal year 1920.

Report of Chief Inspector of Boilers, A. G. Pack. Ry. Jl., vol. 27, no. 1, Jan. 1921, pp. 17–25, 7 figs. Statistics of defects on parts and appurtenances of locomotive and tender, including boiler, together with casualties resulting from failures.

Compressed-Air. Study of the Triple-Expansion Compressed-Air Locomotive and the Utilization of Exhaust Steam in the Compression of Air at High Pressure (Etude sur les locomotives à air comprimé à triple expansion et l'utilisation de la vapeur d'échappement à la production de l'air à haute pression), M. P.-E. Leroux. Bulletin et Comptes rendus mensuels de la Société de l'Industrie minerale, vol. 19, no. 6, Nov.-Dec. 1920, pp. 249–305, 60 figs. Technical and economical study.

Cylinders. Tests of Cast Iron for Locomotive-Cylinder Parts. Am. Mach., vol. 53, no. 27, Dec. 30, 1920, pp. 1221–1222. Mechanical tests at Bureau of Standards.

Electric. See ELECTRIC LOCOMOTIVES.

Internal-Combustion. Internal Combustion Locomotives and Rail Cars of McEwan and Pratt, Ltd., George Frederick Zimmer. Eng. & Indus. Management, vol. 4, no. 27, Dec. 30, 1920, pp. 849–851, 2 figs. Locomotives used on rail tracks in factories, works, plantations, quarries, mines and also for light transitory purposes for erection of contract work. Special attention is given to reversing mechanism.

Lubrication. Lubrication of Locomotives (Lubricaciòn de locomotoras), J. W. D. Ayre. Ingenieria internacional, vol. 5, no. 1, Jan. 1921, pp. 18–23, 25 figs. Details for economical lubrication.

Manufacture. Production Methods in Railway Locomotive Plants. Machy. (Lond.), vol. 17, no. 432, Jan. 6, 1921, pp. 405–410, 11 figs. Practice of Sir W. G. Armstrong, Whitworth & Co., Ltd., Scotswood, Newcastle-on-Tyne.

Mine. Changes in Electric Locomotives to Meet Demands for Heavier Duty, Graham Bright. Coal Age, vol. 19, no. 2, Jan. 13, 1921, pp. 51–56, 11 figs. Frames of bar steel resist damage and assist ventilation of motors. Leaf spring has advantage over helical. Thrust resisted by removable lid of boxing. Detachable rims and split gears are of questionable merit. Tandem locomotives and fan ventilation meet demand for more power.

Oil-Burning. Oil Burning Tests in the Locomotives of the Paris-Lyons-Mediterranee (Essais de chauffage au mazout effectués par la compagnie P. L. M.), M. Pouillon. Revue générale des Chemins de Fer, vol. 39, no. 1, July 1920, pp. 3–7. Burner used was of nappe type with pulverization by means of steam. Tests proved satisfactory in all respects.

Reconstruction. Increasing the Capacity of Old Locomotives, C. B. Smith. Mech. Eng., vol. 43, no. 1, Jan. 1921, pp. 12 and 16. Problems of adapting old-type locomotives to suburban and local service are discussed and items which are to be considered in any program for increasing locomotive capacity are listed. Examples of satisfactory reconstruction are cited.

Speed Capacity. The Speed Capacity of Locomotives, Cecil J. Allen. Ry. Engr., vol. 41, no. 491, Dec. 1920, pp. 489–491. Discussed more particularly in relation to diameter of driving wheels and coupling of axles.

Superheater. Determination of the Best Cylinder Diameter for Superheated Steam Locomotives (Die Bestimmung der zweckmässigsten Zylinderdurchmesser für Heissdampflokomotiven), H. Velte. Annalen für Bewerbe u. Bauwesen, vol. 87, no. 9, Nov. 1, 1920, pp. 65–68, 4 figs. Based on method described by author in same journal (vol. 87, pp. 2–7, 9–14 and 17–22), a number of superheated-steam freight-train locomotives are investigated and a method developed with which it is possible to establish cylinder diameters of such locomotives in such a way as to positively ensure operating qualities required of them.

LUBRICATING OILS

Specifications. Lubricating Oils. Air Service Information Circular, vol. 2, no. 118, Oct. 20, 1920, 7 pp., 3 figs. Specifications and method for testing.

Testing. Methods of Examination of Lubricating Oils, G. F. Robertshaw. Jl. Instn. Petroleum Technologists, vol. 6, no. 24, Oct. 1920, pp. 324–364 and (discussion), pp. 364–378, 1 fig. Methods of testing. Bibliography of lubricating oils.

LUBRICATION

Developments. Advances in the Practice of Lubrication, Henry M. Wells and James E. Southcombe. Can. Chem. & Metallurgy, vol. 5, no. 1, Jan. 1921, pp. 10–13. Experimental work connected with introduction of fatty acids in place of fatty oils. Results of trials on all types of machinery.

Oil-Circulating Systems. Preventing Emulsification in Oil-Circulating Systems, R. E. Langston. Power, vol. 52, no. 19, Nov. 9, 1920, pp. 470–741, 2 figs. Kind of oil to use in circulation systems to avoid forming emulsion.

Problems of. Some Problems of Lubrication, W. B. Hardy. Nature (Lond.), vol. 106, no. 2670, Dec. 30, 1920, pp. 569–572. Experiments to study relation of lubricating power to chemical constitution.

Research. British Lubrication-Research Report. Commerce Reports, no. 9, Jan. 12, 1921, pp. 211–213. Final report of British Department of Scientific and Industrial Research. (Abstract.)

Lubricants and Lubrication. Engr., vol. 130, no. 3390, Dec. 17, 1920, p. 605. Report of Lubricants and Lubrication Inquiry Committee appointed by Advisory Council of Department of Scientific and Industrial Research.

Lubrication. Times Eng. Supp., no. 554, Dec. 1920, p. 381. Report of Lubricants and Lubrication Inquiry Committee set up by Department of Scientific and Industrial Research.

M

MACHINE SHOPS

Layout. Accessibility, Convenience and Cleanliness Make This Machine Shop Efficient, Dever C. Ashmead. Coal Age, vol. 18, no. 26, Dec. 23, 1920, pp. 1269–1271, 4 figs. Layout of machine shop near Hazleton, Pa.

MACHINE TOOLS

Automatic. The Galco Automatic Machines (Les machines automatiques "Galco"), M. Bousquet. Vie technique & industrielle, vol. 2, no. 13, Oct. 1920, pp. 38–44, 15 figs. Swedish machine for cold drawing of rivets, bolts, etc.

Axle-Machining Equipment. Axle Machining Equipment. Engr., vol. 130, no. 3386, Nov. 19, 1920, pp. 508 and 512, 6 figs. Axle facing and centering machine and axle turning lathe exhibited at machine tool exhibition at Olympia.

Belt Drive. Group vs. Individual Drive for Machine Tools, R. F. Jones. Belting, vol. 18, no. 1, Jan. 1921, pp. 59–62, 2 figs. Group offers practically all advantages of individual and in addition first cost is much lower, maintenance charges less and depreciation slower.

Developments. The Shipbuilding, Engineering and Electrical Exhibition, Kelvin Hall, Glasgow. Machy. (Lond.), vol. 17, no. 428, Dec. 9, 1920, pp. 282–285, 8 figs. Developments in machine-tool field.

Power Consumed. Influence of Shape of Chips on the Power Consumption of Machine Tools (Einfluss der Spanform auf den Kraftverbrauch von Werkzeugmaschinen), Th. Damm. Werkstattstechnik, vol. 14, no. 19, Oct. 1, 1920, pp. 507–508, 1 fig. Results of tests carried out on a planing machine, shown in table and chart.

Working Speeds. Alignment Chart for Operating Speeds (Fluchtlinientafel für Laufzeiten), Alfred Leistikow. Betrieb, vol. 3, no. 5, Dec. 10, 1920, pp. 120–123, 1 fig. Presents chart with eight scales, namely, (A) feed in mm.; (B1) and (B2) cutting speed per sec. and per min.; (C) diam. and length in cm.; (D) minutes for 1 cutting; (E) minutes for two and three cuttings; (F) diam. of workpiece in mm.; and (G) revolutions per min.

Alignment Charts for the Calculation of Working Speed of Machine Tools (Fluchtlinientafeln zur Berechnung von Laufzeiten der Werkzeugmaschinen) F. Gabriel. Betrieb, vol. 3, no. 5, Dec. 10, 1920, pp. 115–120, 8 figs. Describes lathe, shaping, and milling-machine calculators introduced by the "Stugra" Central Bur. for Graphic Tables, Waidmannslust, near Berlin, and based on alignment transformation principle.

MALLEABLE IRON

Manufacture. American Malleable Cast Iron—II. Iron Trade Rev., vol. 68, no. 3, Jan. 20, 1921, pp. 213–218, 2 figs. Developments of malleable industry in U. S.

See also CASTINGS, Malleable.

MANGANESE STEEL

Machining. Manganese Steel and Methods of Machining It, S. A. Hand. Am. Mach., vol. 54, no. 2, Jan. 13, 1921, pp. 43–45, 3 figs. Grinding is only method of machining.

MARINE BOILERS

Electric Welding. A Revolution in Marine Boiler Construction, Francis Butt-Gow. Boiler Maker, vol. 21, no. 1, Jan. 1921, pp. 1–4, 9 figs. Electric welding of Scotch marine boilers at works of R. & W. Hawthorn Leslie & Co., England.

Manufacture. Willamette's War Work, Fred H. Colvin. Am. Mach., vol. 54, no. 3, Jan. 20, 1921, pp. 105–107, 6 figs. Production manufacture of marine boilers.

MARINE ENGINES

Governors. The Ramsay Marine Governor. Practical Engr., vol. 62, no. 1764, Dec. 16, 1920, pp. 388–391, 6 figs. Anticipating valve comes automatically into action when lift of ship's stern brings propellor dangerously near surface.

[See also OIL ENGINES, Marine.]

MEASUREMENT

Optical Devices. Improvements in Measuring Tools (Neurungen an Messwerkzeugen), Max Kurrein. Werkstattstechnik, vol. 14, nos. 19 and 20, Oct. 1 and 15, 1920, pp. 513–517 and 538–544, 46 figs. Details of various new measuring-tool constructions by the Fried. Krupp Corp., and of accurate measuring apparatus by firm of Carl Zeiss, particularly optical measuring devices.

METALS

Fatigue. The Relation of Recoverance to the Fatigue of Metals, Robert G. Guthrie. Jl. Soc. Automotive Engrs., vol. 8, no. 1, Jan. 1921, pp. 65–68, 2 figs. Description of modulimeter, an apparatus for measuring recoverance. Recoverance is capacity of material to return immediately energy that has been imparted to it by any external force.

METEOROLOGY

Atmospheric Pressure-Temperature Relations. The Relationship Between Pressure and Temperature at the Same Level in the Free Atmosphere, E. H. Chapman. Proc. Royal Soc., vol. 98, series A, no. A691, Dec. 3, 1920, pp. 235–248, 1 fig. Correlation coefficients between pressure and temperature at same level in free atmosphere.

METRIC SYSTEM

U. S. Senate Bill. A New Metric System Bill. Iron Age, vol. 106, no. 26, Dec. 23, 1920, pp. 1677. Principal features of bill introduced into Senate on Dec. 21, 1920, to establish Metric System in United States.

The Metric System Bill Introduced in the Senate. Am. Mach., vol. 53, no. 27, Dec. 30, 1920, pp. 1248–1249. Text of bill providing for compulsory use of Metric System in United States recently introduced in Senate.

MILLING

Continuous. Continuous Milling of Pump Bodies. Am. Mach., vol. 54, no. 3, Jan. 20, 1921, pp. 108–109, 5 figs. Table revolves to feed work, and castings are replaced while machine is cutting.

MILLING MACHINES

Cutter Selection. Proposals for New Factory Instruction Sheets (Entwürfe neuer Betriebsblätter). Betrieb, vol. 3, no. 4, Nov. 25, 1920, pp. 31–32. Proposal of the Committee for Economic Production (AWF) for a new instruction sheet containing directions for the selection and manipulation of milling cutters.

Horizontal. Horizontal Milling Machine. Eng., vol. 110, no. 2869, Dec. 24, 1920, pp. 834–836, 8 figs. Single pulley type machine constructed by Alfred Herbert, Coventry, England. Pulley is mounted on ball bearings, which are fitted to fixed sleeve attached to body of machine.

Locomotive-Frame. Milling Machine for Locomotive Frames, Hartwig Orenstein. Eng. Progress, vol. 1, no. 12, Dec. 1920, pp. 365–366. Three-column milling machine for milling frames having 11 meters in length, used at locomotive works in Berlin.

Multiple. Large Multiple Milling Machines (Grosse Mehrfach-Fräsmaschine), Der praktische Maschinen-Konstrukteur, vol. 53, no. 38, Sept. 25,

1920, pp. 161–165, 4 figs. Details of a large milling machine built by the Schiess Machine Factory Corp. for the machining of Diesel-engine beds and other large Diesel-engine parts. Operates with three double spindles, each of which independently is driven by a special motor, resulting in a great simplification of driving parts.

MINE HAULAGE

Colliery Plant. Electric Haulage and Ventilating Plant at the Easington Colliery. Eng., vol. 110, no. 2868, Dec. 17, 1920, pp. 804–806 and 808, 10 figs. Various electric haulages comprise two large main-and-tail haulages of 600 hp. and 450 hp., respectively, and three endless haulages, two of which are of 160 hp. and third of 85 hp.

Continuous. Continuous Hoisting from Great Depths (Stetige Förderung aus grossen Teufen), A. Winkel. Fördertechnik u. Frachtverkehr, vol. 13, nos. 19, 20 and 21, Sept. 17, Oct. 1 and 15, 1920, pp. 173–176, 184–188 and 195–198, 12 figs. Notes on the development of continuous hoisting systems for deep shafts and determination of the economically and technically most advantageous type. Comparison of electric and steam installations of same capacity.

MOMENT OF INERTIA

Unsymmetrical Sections. Calculating the Strength of Unsymmetrical Sections, G. S. Chiles and R. G. Kelley. Machy. (N. Y.), vol. 27, no. 4, Dec. 1920, pp. 345–348. Methods of determining moment of inertia, together with formulas for obtaining section modulus and radius of gyration.

MOTOR BOATS

Engines. Commercial Motor Boats and the Diesel Engine, G. D. Cavison. Jl. Soc. Automotive Engrs., vol. 8, no. 1, Jan. 1921, pp. 46–50, 7 figs. Chart showing comparative operating costs of Diesel, hot-bulb and gas engines.

MOTOR PLOWS

Wheel Design. Plowing by Machinery (Le problème de l'adhérence), F. Mirès. Vie technique & industrielle, vol. 2, no. 15, Dec. 1920, pp. 207–211, 21 figs. Types of wheels required to develop sufficient adherence between wheels and soil. (To be continued.)

MOTOR-TRUCK TRANSPORTATION

Germany. Development of Public Motor Transport in Germany, Benno R. Dierfeld. Automotive Industries, vol. 43, no. 26, Dec. 23, 1920, pp. 1251–1254, 3 figs. Vehicles are operated in large fleets by trained staffs, service being controlled by motor transportation companies owned by local governments. Post Office Department operates passenger vehicles.

MOTOR TRUCKS

Axles. A New Dual Reduction Truck Axle, P. M. Heldt. Automotive Industries, vol. 44, no. 1, Jan. 6, 1921, pp. 10–13, 6 figs. Dual reduction axle with drop-forged housing of double banjo type.

Body Design. Engineering Features of New British Trucks at Olympia, M. W. Bourdon. Automotive Industries, vol. 43, no. 25, Dec. 16, 1920, pp. 1207–1212, 20 figs. Careful attention to details heretofore neglected and many refinements in design feature new models. Bristol 3 to 4-ton has electric lights, new transmission and 16-in. single-plate clutch. Halley uses 6-cylinder engine, shaft brake at rear of worm and novel steering connections. Austin has only unit powerplant. Single plate clutch, propeller shaft brakes, overhead worms, plain bearing rear axles and steel wheels, generally used.

Design. The Trend of Motor Truck Design for 1921, Victor W. Page. Sci. Am., vol. 124, no. 2, Jan. 8, 1921, pp. 30–31 and 38–40, 12 figs. Brief survey of features displayed by 682 American models.

German-Built. Motor Lorries, Rudolf Urtel. Eng. Progress, vol. 1, no. 12, Dec. 1920, pp. 360–363, 5 figs. Survey of recent developments in Germany and record of standardization work.

Quantity Production. Fixtures for Quantity Production of Truck Parts—I. Metal Trades, vol. 11, no. 12, Dec. 1920, pp. 489–493, 8 figs. Fixtures used by Fageol Motors Co. (To be continued.)

Specifications. Complete Mechanical Specifications of all Makes of 1921 Gasoline Motor Trucks. Commercial Vehicle, vol. 23, no. 11, Jan. 1, 1921, pp. 356–378. Details of 527 gasoline, 22 electric and one steam motor truck chassis as produced by 227 American truck manufacturers.

Internal-Combustion Truck Specifications. Power Wagon, no. 194, Jan. 1921, pp. 42–59. List of specifications of 570 makes.

Wheels. Machining Motor Truck Wheels. Machy. (N. Y.), vol. 27, no. 4, Dec. 1920, pp. 349–355, 15 figs. Also Machy. (Lond.), vol. 17, no. 432, Jan. 6, 1921, pp. 411–417, 15 figs. Practice of Clark Equipment Co., Buchanan, Mich., in production of steel truck wheels.

N

NAVIGATION

Hydrophone. U. S. Navy MV Type of Hydrophone as an Aid and Safeguard to Navigation, H. C. Hayes. Proc. Am. Philosophical Soc., vol. 59, no. 5, 1920, pp. 371–404, 12 figs. Uses of apparatus developed during war for determining direction of submerged submarine.

NICKEL

Properties. Physical Properties of Nickel, Paul D. Merica. Chem. & Metallurgical Eng., vol. 24, no. 2, Jan. 12, 1921, pp. 73–76, 5 figs. Compilation of literature references and original and unpublished work on various physical, mechanical, thermal, electrical and optical properties of pure nickel.

NICKEL STEEL

Instability. Cause of Instability of Nickel Steels, and Its Removal (Cause de l'instabilité des aciers au nickel; son élimination), Ch.-Ed. Guillaume. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 22, Nov. 29, 1920, pp. 1039–1041. Instability is due to slow transformation of cementite. Addition of third metal having greater affinity for carbon than iron prevents formation of cementite and thus increases stability of alloy.

NICKEL-CHROMIUM STEEL

Uses. Applications of Alloy Steels in Automotive Industries, H. J. French. Automotive Manufacturer, vol. 42, no. 9, Dec. 1920, pp. 24–28, 9 figs. Nickel-chromium steels and their advantageous properties, especially for transmission and other gears, aeroplane and other crankshafts, and other highly important parts.

O

OIL ENGINES

Manufacture. Prospects and Problems in Construction of Oil Engines (Aussichten und Aufgaben des Oelmaschinenbaues), Paul Rieppel. Zeit. des Vereines deutscher Ingenieure, vol. 64, nos. 49 and 50, Dec. 4 and 11, 1920, pp. 1021–1026 and 1051–1055, 10 figs. Prospective development of the injection-type and carburetor engines; the injection-type engine for marine purposes; combustion phenomenon and control of heat, the compressorless engine. Special technical problems: Wheel gearing and reversing; construction materials and lubrication; the injection-type engine as locomotive; starting and power transmission; hydraulic drives; carburetor engines for agricultural work and in factories, for automobiles and aeroplanes. Carburation inside and outside of cylinder.

Marine. Modern Marine Oil Engines. Shipbuilding & Shipping Rec., Special Number, Jan. 5, 1921, pp. 58–60, 5 figs. Survey of different types of internal-combustion engine available for propulsion of merchant ships.

Solid-Injection. The Solid-Injection Oil Engine, Edgar J. Kates. Power, vol. 52, no. 26, Dec. 28, 1920, pp. 1008–1010, 3 figs. Fuel consumption test on 200-hp. solid injection oil engine.

OIL FUEL

Coal and Gas vs. Fuel Oil. Power Plant Eng., vol. 25, no. 1, Jan. 1, 1921, pp. 51–55, 9 figs. Chart for determining relative costs of oil, gas and coal for equal economy.

Specifications. Specifications for Oil Fuel (Au sujet des conditions de recette des combustible liquides), Pierre Appell. Chaleur & Industrie, no. 8, Nov.-Dec. 1920, pp. 490–495. Specifications of French and British navies and of U. S. Bureau of Mines.

Uses. Uses of Oil Fuel (Les emplois de mazout), Norbert Lallie. Vie technique et industrielle, vol. 2, nos. 13, 14 and 15, Oct., Nov. and Dec., 1920, pp. 25–32, 121–125 and 217–223, 42 figs. Oct.: Industrial uses, and methods of combustion; Nov. and Dec.: Types of burners.

OILS

Slushing. Slushing Oils, Percy H. Walker and Lawrence L. Steele. Technologic Papers, Bur. of Standards, no. 176, Oct. 14, 1920, 23 pp. Desired properties of slushing oils. Laboratory tests on slushing compounds. Proposes specifications for slushing greases suitable for protection of exposed bright metal.

OPEN-HEARTH FURNACES

Manganese Utilization. The Utilization of Manganese in Basic Open-Hearth Furnaces (Beiträge zur Frage der Manganausnutzung im basischen Martinofen), Erich Killing. Stahl u. Eisen, vol. 40, no. 46, Nov. 18, 1920, pp. 1545–1547. States that utilization can be increased (1) if meltings are tapped from slag at moment of greatest reduction of manganese; (2) if manganese charge is not measured too high (1.6 to 1.8 per cent); (3) if the bases are admitted in such quantities that there is neither excess nor deficiency in proportion to absorption capacity of slag; (4) by as low a charge of lime-binding elements as possible; (5) by as high temperature as possible; and (6) admission of manganese in metallic form.

OXY-ACETYLENE CUTTING

Steel Plate. Cutting Steel Plate with a Torch. Gas Age, vol. 47, no. 1, Jan. 10, 1921, pp. 9–10, 2 figs. Machines for operating oxy-acetylene-cutting torch adopted to irregular surfaces and with automatic feed.

Torch Tips. Drilling Davis-Bournonville Cutting Torch Tips. Autogenous Welding, Jan. 1921, pp. 3–8, 14 figs. Description and illustration of drilling operation.

OXY-ACETYLENE WELDING

Efficiency of. Efficiency of Oxy-Acetylene Welding, Benjamin Heyman. Welding Engr., vol. 5, no. 12, Dec. 1920, pp. 29–37, 2 figs. Results of tests. Welding efficiency was calculated as ratio of ultimate strength of welded material in pounds per square inch and ultimate strength of unwelded material in pounds per square inch. Efficiencies thus computed varied from 77.2 to 90.5 per cent.

P

PEAT

Briquets. Manufacture of Peat Briquets in Sweden (Möjlighet för torvbrikettfabrikation i Sverige), Alf. Larson. Teknisk Tidskrift (Veckoupplagan), vol. 50, no. 42, Oct. 16, 1920, pp. 461–471, 12 figs. Made from deposits containing 50 per cent water.

Pulverized. The Utilization of Pulverized Peat, C. F. Herington. Power Plant Eng., vol. 25, no. 1, Jan. 1, 1921, pp. 60–62, 2 figs. Experience of plants in Minneapolis, Minn.

PENDULUM

Complex Motion. Study of Complex Pendular Systems (Études sur les systèmes pendulaires complexes), Luc Denis. Vie technique & industrielle, vol. 2, no. 15, Dec. 1920, pp. 235–236, 4 figs. Pendulum mounted on mass possessed of alternating rotary motion. (To be continued.)

PETROLEUM

Products of, Transporting. Hazards of Handling and Transporting Volatile Petroleum Products, C. P. Bowie. Reports of Investigations, Bur. of Mines, Dept. of Interior, serial no. 2195, Dec. 1920, 2 pp. Experiments showed that highly explosive mixtures of hydrocarbon vapors and air are produced when mixture contains 1.4 to 6 per cent hydrocarbon vapor and dangerous flashes may be produced with mixtures containing less or more than these proportions.

Refining. Petroleum Refining Process and Problems, H. H. Hill. Jl. Soc. Automotive Engrs., vol. 8, no. 1, Jan. 1921, pp. 51–53. Common types of refining plants.

Sulphur in. Sulphur in Petroleum Oils, C. E. Waters. Technologic Papers Bur. of Standards, no. 177, Oct. 20, 1920, 26 pp., 1 fig. Theories concerning origin of sulphur and sulphur compounds which are found in crude petroleum. Tests for detection of sulphur are described and copper test is shown to be of great delicacy.

PIG IRON

Synthetic. Furnace Earns Cost in Two Months, Herschell L. Hatt. Foundry, vol. 49, no. 1, Jan. 1, 1921, pp. 30–32, 1 fig. Experience with home-made electric furnace operated for producing synthetic pig iron from steel scrap.

Makes Pig Iron in Novel Furnaces, Herschell L. Hatt. Iron Trade Rev., vol. 68, no. 2, Jan. 13, 1921, pp. 149–151, 1 fig. Home-made electric furnace of simple construction operated for producing synthetic pig iron from steel scrap.

PIPE, CAST IRON

Founding. Cast Iron Pipe Founding at Fort William Plant, P. R. Hurley. Can. Foundryman, vol. 12, no. 1, Jan. 1921, pp. 17–19, 4 figs. Method and equipment of manufacturing cast-iron water and gas pipe.

How Soil Pipe Castings Are Made, Pat Dwyer. Foundry, vol. 49, no. 2, Jan. 15, 1921, pp. 43–47 and 50, 7 figs. Standardized manufacturing practice at plant of Somerville Iron Works, Somerville, N. J.

PIPE LINES

Calculation. The Scientific Calculation of Pipe Lines (Une méthode scientifique pour le calcul des pipe-lines), Vie technique & industrielle, vol. 2, no. 15, Dec. 1920, pp. 229–233, 4 figs. Equations deduced from theory of flow of fluids on solids.

Valves. Effect of Small Gate or Valve in Larger Pipe Line, T. E. Lally. New England Water Works Assn., vol. 34, no. 4, Dec. 1920, pp. 302–311, 4 figs. Tests to determine loss of pressure.

PISTONS

Aluminum Alloys. Aluminum Alloy Pistons, Ernest V. Pannell. Metal Industry (N. Y.), vol. 19, no. 1, Jan. 1921, pp. 15–17, 8 figs. Advantages of aluminum, alloys in use, their treatment and design, and manufacture of pistons for gasoline motors.

PLANERS

Electrically Driven. Electrically Driven Planing Machine. Engr., vol. 130, no. 3390, Dec. 17, 1920, p. 619. Machine has stroke of 30 ft. and can accommodate work up to 12 ft. in width and 8 ft. in height. Including electrical equipment machine weighs about 100 tons. Driving motor is of 70 b.hp.

Practice in Machine-Tool Plants. Production Planing in Machine Tool Plants, Edward K. Hammond. Machy. (N. Y.), vol. 27, no. 5, Jan. 1921, pp. 409–419, 15 figs. Planer practice in number of plants building milling machines.

Safety Devices. Safety Arrangements for Plate-Edge Planing Machines (Sicherheitsvorrichtungen für Blechkantenhobelmaschinen), Hugo Becker. Zeit des Vereines deutscher Ingenieure, vol. 64, no. 49, Dec. 4, 1920, pp. 1033–1037, 8 figs. Different electric drives for plate-edge planing machines with right-angled beds; safety devices for preventing the tables from colliding at the junction of beds.

PLATES

Stresses in. The Bending Stress of Plates Under Concentrated Loads (Die Biegungsbeanspruchung von Platten durch Einzelkräfte), A. Nádai. Schweizerische Bauzeitung, vol. 76, no. 23, Dec. 4, 1920, pp. 257–260. Stress is determined by author in and near the pressure surface of a thick circular plate bent by a single force.

POWER GENERATION

Development in 1920. Review of the Year. Power, vol. 53, no. 1, Jan. 4, 1921, pp. 2–21. Tendencies in design and practice in power plant field, and economic problems that must be met. Adoption and promulgation of A.S.M.E. boiler code. Studies of steam engine, uniflow engine and high-speed turbo-blowers. Progress in accident prevention.

POWER PLANTS

Development. Engineering Developments of 1920–21. Elec. World, vol. 77, no. 1, Jan. 1, 1921, pp. 17–38, 35 figs. Important developments are classified under (1) generation and protection; (2) transmission and distribution; (3) science and research, and (4) lighting and industrial. Recent tendencies and practices as revealed by prominent installations carried out in 1920 are studied for each one of these divisions.

POWER STATIONS

Design. Unit Idea in Power Station Design, Louis R. Lee. Elec. Ry. Jl., vol. 57, no. 2, Jan. 8, 1921, pp. 73–76, 1 fig. Application of unit principle to generating plants as a whole.

POWER TEST CODES

Reciprocating Steam Engines. See STEAM ENGINES, A.S.M.E. Test Code.

POWER TRANSMISSION

Pneumatic. Essential Properties of Pneumatic Transmission in a Closed Cycle (Propriétés essentielles des transmission pneumatiques en cycle fermé), Jacques de Lassus. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 21, Nov. 22, 1920, pp. 992–995. Laws governing polytropic changes in cycle proposed in Comptes rendus, Nov. 8, pp. 899–901.

Power Transmission by an Invariable Mass of Gas in a Closed Space (Sur une transmission d'énergie méchanique utilisant unemassei nvariable de gaz en circuit fermé), Jacques de Lassus. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 19, Nov. 8, 1920, pp. 899–901. Adiabatic compression in a closed space.

PRESSES

20-Ton. Power Press with Pressure Range to 20 Tons. Iron Age, vol. 107, no. 2, Jan. 13, 1921, p. 140, 1 fig. Pressure exerted upon work ranges from few pounds to 20 tons and is applied by operator on foot pedal.

PRESSWORK

Electric Motor Plant. Press Work in an Electric Motor Plant—II. Machy. (N. Y.), vol. 27, no. 4, Dec. 1920, pp. 340–344, 11 figs. Methods used in Power Press Department of General Electric Co., Lynn, Mass.

PROFIT SHARING

England. Teaching Workers to Think "Production," Cecil Chisholm. Factory, vol. 26, no. 1, Jan. 1, 1921, pp. 40–42. Experience in English works with profit-sharing systems.

PULVERIZED COAL

Advantages. Pulverized Coal. Power Plant Eng., vol. 25, no. 1, Jan. 1, 1921, pp. 56–60, 9 figs. Graph showing comparative heat values for various fuels.

[See also STEEL CASTINGS, Annealing.]

PUMPS, CENTRIFUGAL

Induction Motors for. Variables Speed Induction Motors for Centrifugal Pumps. Eng. News-Rec., vol. 85, no. 24, Dec. 9, 1920, pp. 1126–1127, 3 figs. Comparison of overall efficiencies for centrifugal unit, based on tests on motor-driven three-stage pump run at normal speed throttled or variable speeds unthrottled.

Turbine. New Contributions to the Theory of Side Thrust, Side-Thrust Equalizing Devices and Clearance Losses in Turbine Pumps (Neue Beiträge zur Theorie des Achsschubes, der Achsschubausgleichsvorrichtungen und Spaltverluste in Turbinenpumpen), L. W. Weil. Zeit. für das gesamte Turbinenwesen, vol. 17, nos. 25, 26, 28, 30 and 31, Sept. 10, 20, Oct. 10, 30 and Nov. 10, 1920, pp. 289–294, 301–307, 331–335, 356–358 and 369–372, 28 figs. Describes theoretically developed, practical and useful methods for calculation of side-thrust forces in turbine pumps and arrangements for combating them.

R

RAILS

Failure. Rail Failure Statistics for 1919, M. H. Wickhorst. Bul. Am. Ry. Eng. Assn., vol. 22, no. 229, Sept. 1920, pp. 47–87. Statistics of rail failure collected for year ending Oct. 21, 1919, furnished by railroads of United States and Canada, in response to circular sent out by American Railroad Association.

Flat-Bottom vs. Bull-Head. The Case of the Bull-Head Rail. Ry. Gaz., vol. 33, no. 23, Dec. 3, 1920, pp. 736–737. Comparison of relative advantages of flat-bottom and bull-head rails for railway track purposes.

RAILWAY CONSTRUCTION

Economics. Reeders for Railroads, Charles A. Morse. Mech. Eng., vol. 43, no. 1, Jan. 1921, pp. 19–20. Economical factors involved in construction of branch lines.

RAILWAY ELECTRIFICATION

Canada. Electrical Operation on the Canadian National. Ry. Elec. Engr., vol. 12, no. 1, Jan. 1921, pp. 25–29, 9 figs. Modification of original plan as result of amalgamation of Canadian Northern with Government railways.

Chicago. Chicago Electrification and Elevation C., M. & St. P. Ry. Eng. News-Rec., vol. 85, no. 26, Dec. 23, 1920, pp. 1226–1230, 9 figs. Third-rail passenger and trolley freight service on Evanston suburban line. Concrete walls and trestle. Precast and poured bridge decks.

European Developments. Status of Heavy Traction Abroad. Elec. Ry. Jl., vol. 57, no. 1, Jan. 1, 1921, pp. 31–36. Survey of practice in Great Britain colonies and in Continental Europe.

France. Partial Electrification of the French Railways (Electrification partielle des Chemins de fer français), A. Tretél. Électricien, vol. 36, no. 1265, Dec. 1, 1920, pp. 505–514. Progress in carrying out projects for electrification of three of principal French railways.

India. The Electrification of Indian Railways. Engr., vol. 130, nos. 3387–3388, Nov. 26-Dec. 3, 1920, pp. 530–531, 3 figs, 550–551, 4 figs. Comparative performance of electric and steam locomotives of Indian Northwestern Railway.

Operating Results from. The Electrification of Steam Railroads. Ry. Age, vol. 70, no. 1, Jan. 7, 1921, pp. 101–106, 8 figs. Brief survey of operating results on Norfolk & Western and C. M. & St. P.

Tunnels. New Catenary Construction for the Hoosac Tunnel. Ry. Elec. Engr., vol. 12, no. 1, Jan. 1921, pp. 17–20, 6 figs. Tunnel is 4¾ miles in length, being longest in U. S. Renewal of overhead equipment under traffic.

St. Clair Tunnel Operation Most Successful, R. L. Herman. Ry. Elec. Engr., vol. 12, no. 1, Jan. 1921, pp. 21–24, 6 figs. Grand trunk electrical installation. Tunnel is single-track tube 6032 ft. in length with approaches totalling 5603 ft.

Sweden. The Electrification of the Swedish State Railroads (Die Elektrisierung der schwedischen Staatsbahnen), Axel F. Enström, Emil Alm and Carl A. Rossander. Elektrotechnische Zeit., vol. 41, nos. 45 and 46, Nov. 11 and 18, 1920, pp. 893–896 and 913–916. Expert testimony of a commission appointed by the Royal Swedish State Railroad Administration setting forth relative merits of direct current and single-phase alternating current. For the section Gothenburg-Stockholm preference is given to the single-phase alternating current, and it is recommended that motive power be generated in part directly in power station and in part through conversion from three-phase current at one or a few points.

Switzerland. Electrification of the Sion-Lausanne Lines of the Swiss Federal Railways (Electrification de las ligne Sion-Lausanne des C F F). Bulletin Technique de la suisse romande, vol. 46, no. 24, Nov. 27, 1920, pp. 277–278. Details of project.

The Electrification of the Swiss Railways (L'électrification des chemins de fer Rhétiques), H. Lang. Bulletin technique de la Suisse romande, vol. 46, no. 25, Dec. 11, 1920, pp. 289–294, 9 figs. Single-phase system at 10,000-volts and 16⅔ periods per second has been decided upon.

RAILWAY OPERATION

Train Control. The Marvel of Train Control, Robert G. Skerrett. Sci. Am. Monthly, vol. 3, no. 1, Jan. 1921, pp. 63–65, 4 figs. System for automatic action of air and steam hose of railway cars.

RAILWAY SIGNALING

Block System. Absolute Block-System with Closed Sections Worked by Means of the Telephone on the Belgian State Railways, L. Weissenbruch and J. Verdeyen. Bul. Int. Ry. Assn., vol. 2, no. 12, Dec. 1920, pp. 878–888. Records of operation.

Wireless Waves. Repetition of Track Signals on Board the Locomotive (Étude sur la répétition des signaux de voie à bord des locomotives), J. Bethenod. Radioélectricité, vol. 1, no. 6, Nov. 1920, pp. 292–297, 5 figs. Survey of applications of principles of wireless telegraphy to the repetition of danger and other signals on the cab of locomotive. Comparative study of schemes developed in France with those devised in United States. (To be continued.)

RAPID TRANSIT

New York City. Functions of Rapid Transit Lines in Cities, Henry M. Brinckerhoff. Eng. News-Rec., vol. 85, no. 26, Dec. 23, 1920, pp. 1235–1239, 1 fig. Capabilities of subways, elevated railways and surface lines compared from statistical records of New York City.

REFRIGERATING MACHINES

Carbon-Dioxide. The Escher Wyss & Co. Carbon-Dioxide Ice and Refrigerating Machine (Kohlensäure-Eis- und Kühlmaschine System Escher Wyss & Co.). Zeit. für Sauerstoff- u. Stickstoff-Industrie, vol. 12, no. 19–20, Oct. 1920, pp. 77–80, 3 figs. Based on evaporation of CO_2 and its condensation through compression and cooling. Advantages are said to be that machine consists of only three parts. Refrigerator, compressor and condenser, and no distillation or rectifying apparatus are required; the CO_2 is chemically inactive and, therefore, does not affect any of machine parts or packing material; purity of cooling water remains unchanged. Other advantages are durability, easy manipulation, low cost, minimum depreciation, lack of danger, etc.

REFRIGERATING PLANTS

Fish Freezers. St. Pierre Fish Freezer. Refrig. World, vol. 56, no. 1, Jan. 1921, pp. 11–16, 9 figs. Fish freezing and storing plant built for French Government on Island of St. Pierre. Machinery equipment and storage facilities are designed to take care of freezing of 200,000 bbls. of fish in 24 hr. and storing of 6,000,000 lb. of frozen fish, boxed ready for shipment.

Gas Power for. Gas Power for Refrigerating Plants, Geo. H. Trout. Ice & Refrigeration, vol. 60, no. 1, Jan. 1921, pp. 9–10. Cost of operation. Advantages of gas power.

Packing Plants. New Armour Plant at Kansas City. Power, vol. 52, no. 25, Dec. 21, 1920, pp. 966–969, 5 figs. Horizontal ammonia compressor of 500-ton capacity and generating units with mixed-pressure turbines of extraction type.

Safety Regulations. Safety Regulations for Refrigerating Plants, G. H. Crawford. Power, vol. 53, no. 1, Jan. 4, 1921, pp. 28–30, 7 figs. Study of regulations of various cities and states.

REFRIGERATION

Fish. Fish Research Committee. Interim Report on Its Investigations. Cold Storage, vol. 23, no. 273, Dec. 16, 1920, pp. 310–312, 1 fig. Suggested model low-temperature brine-freezing fish tank.

Standard Ton. Standard Ton of Refrigeration, F. E. Matthews. Refrig. World, vol. 56, no. 1, Jan. 1921, pp. 16–17. It has been defined by adoption of recommendations of special committee by Am. Soc. Refrigerating Engrs. at 288,000 B.t.u.

Standard Unit of Refrigeration, F. E. Matthews. Ice & Refrigeration, vol. 60, no. 1, Jan. 1921, pp. 49–50. Unit of 288,000 B.t.u. has been officially adopted by Am. Soc. Refrigerating Engrs.

RESEARCH

Developments in. 1920: A Retrospect. Chem. Age (Lond.), vol. 4, no. 81, Jan. 1, 1921, pp. 4–6. Developments in research, industry and invention.

Engineering Foundation. Engineering Foundation: Its Work and Needs, Alfred D. Flinn. Min. & Sci. Press, vol. 122, no. 3, Jan. 15, 1921, pp. 86–87. Advisability of establishment by Engineering Foundation of Engineering Research Institute and Laboratory.

Industrial Associations. Industrial Research Associations—IV, Arnold Frobisher. Nature (Lond.), vol. 106, no. 2666, Dec. 2, 1920, pp. 443–446. British Research Association for woolen and worsted industries.

Industrial Research Associations—V, S. G. S. Panisset. Nature (Lond.), vol. 106, no. 2667, Dec. 9, 1920, pp. 475–476. British Portland Cement Research Association.

Industrial Research Associations—VII, H. S. Rowell. Nature (Lond.), vol. 106, no. 2669, Dec. 23, 1920, pp. 538–540. Research Association of British motor and allied manufacturers.

Lumber Industry. Research and Boards, Ovid M. Butler. Sci. Am. Monthly, vol. 3, no. 1, Jan. 1921, pp. 59–62, 6 figs. Need of establishing laboratories to study problems of lumber industry.

Machinery. Complete Laboratory for Research in Machinery. Iron Trade Rev., vol. 68, no. 2, Jan. 13, 1921, pp. 152–153, 4 figs. Research laboratory of National Lamp Works of General Electric Co., Cleveland installed to test and to study further development of machines used in manufacture of lamps.

Paper. Progress of U. S. Paper Laboratory in 1920. Paper, vol. 27, no. 18, Jan. 5, 1921, pp. 14–16. Important work has been done on paper-testing machines, paper substitutes, determination of sizing, quality of paper, fibre studies, etc.

RIVETS

Heating by Electricity. Heating Rivets by Electricity, J. R. Bower. Jl. Engrs. Club of Phila., vol. 38–1, no. 193, Jan. 1921, pp. 1–7, 14 figs. Principle of operation and details of construction of electric rivet heater. Comparison of heating rivets by electricity with other methods of heating.

Standards. Report of the German Industry Committee on Standards (N D I) (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 5, Dec. 10 1920, pp. 69–81, 14 figs. Proposals of the Board of Directors for round-head rivets for boiler and steel construction, symbols for rivets and screws in iron structures; countersunk-head rivets, etc. Proposed standards for concrete boundary and milestones; drain-pipe laterals; sheet-metal rivets; rules of the Committee for Units and Formular Values (AEF).

ROLLING MILLS

Electrically Driven. Electric Blooming Mill in Delaware. Iron Age, vol. 106, no. 27, Dec. 30, 1920, pp. 1733, 1 fig. Plant of Penn Seaboard Steel Corp. Rolling capacity consists of 34-in. two-high reversing blooming mill.

Operation. Practical Pointers on Rolling Mill Operation, W. S. Standiford. Can. Machy., vol. 24, no. 26, Dec. 23, 1920, pp. 555–558, 2 figs. Comparison of English and American methods of rolling.

S

SAFETY

Compressed-Air Work. Revised Rules on Compressed-Air Work in New York. Eng. News-Rec., vol. 85, no. 26, Dec. 23, 1920, p. 1225. Conference of engineers, contractors, workmen and state departments adopts measures for safety of men and work.

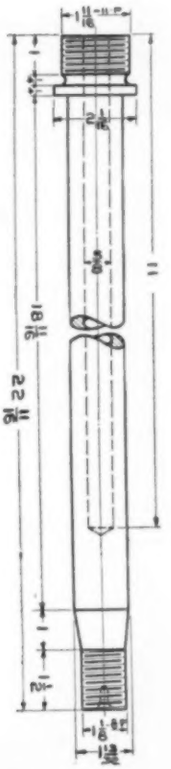
Industrial. Securing Safety Through Competition. Iron Age, vol. 106, no. 26, Dec. 23, 1920, p. 1679, 1 fig. Plan of Dodge Mfg. Co. consists in dis-

The Best Production Methods Are the Most Economical

There is only one *best* method in turret lathe practice. Our Engineers are constantly studying and experimenting to reach that best method and keep our turret lathes up to their high standard.

The results of their study and experimenting are yours to apply to your production problems. Just write us and we'll send one of our engineers to consult with you. He may be able to save you considerable money by suggesting a tool or two or perhaps by re-arranging the tools you have. This is part of our service to you.

Turret Lathes from 4½" x 44"—21" Swing to ⅝" x 4"—10" Swing.



A. W. & S. No. 3-A finishes one of these Air Brake Pump Pistons of cold rolled stock every 20 minutes in an eastern railroad shop. This is a difficult railroad job.

The Warner & Swasey Company

Cleveland, U. S. A.

NEW YORK OFFICE: Singer Building BUFFALO OFFICE: Iroquois Building BOSTON OFFICE: Oliver Building DETROIT OFFICE: Ford Building
CHICAGO OFFICE AND SHOW ROOM: 618-622 Washington Boulevard MILWAUKEE OFFICE: 209 Sycamore Building
DAYTON OFFICE: 518 Mutual Home Building INDIANAPOLIS OFFICE: 940 Lemcke Annex

Domestic Agents:
Fulton Supply Company, Atlanta, Ga.
Young & Vann Supply Company, Birmingham, Ala.
Woodward, Wight & Company, New Orleans, La.
Salt Lake Hardware Company, Salt Lake City, Utah.
Smith-Booth-Usher Company, Los Angeles, Calif.
Fred Ward & Son, San Francisco, Calif.
Portland Machinery Company, Portland, Ore.
Hallidie Machinery Company, Seattle, Wash.
Hendrie & Bolthoff Mfg. & Supply Company, Denver, Col.
Peden Iron & Steel Company, Houston, Texas.

Canadian Agents:
A. R. Williams Machinery Company, Ltd., Toronto, Winnipeg, Vancouver, St. John.
Williams & Wilson, Ltd., Montreal.

Foreign Agents:
Charles Churchill & Company, Ltd., London, Birmingham, Manchester, Bristol, Newcastle-on-Tyne, Glasgow.
Allied Machinery Company, Paris, Turin, Zurich, Barcelona, Brussels.
Wilhelm Sonesson Company, Malmo, Copenhagen, Stockholm, Gothenburg.
R. S. Stockvis en Zonen, Rotterdam.
Benson Brothers, Sydney, Melbourne, Adelaide.
Yamatake & Company, Tokyo, Osaka, Nagoya, Fukuoka, Dairen.
McLeod & Company, Calcutta.
Andersen, Meyer & Company, Ltd., Shanghai.
Brossard-Mopin & Company, Saigon, Singapore, Haiphong.

ENGINEERING INDEX (Continued)

tributing small cash prizes to workers and arousing competition in departments.

Standards. Safety Standards of the Industrial Board. Commonwealth of Pennsylvania, Dept. of Labor & Industry, vol. 1, no. 4, 9 pp. Railings, toe boards, platforms and runways.

SAND BLAST

Apparatus. Sand-Blasting, C. W. Starker. Machy. (N. Y.), vol. 27, no. 5, Jan. 1921, pp. 458–462, 11 figs. Types of apparatus, abrasives, nozzles, air pressures, dust exhausting, etc.

SCIENTIFIC INSTRUMENTS

Manufacture. Operations in the Manufacture of Scientific and Optical Instruments—I. Machy. (Lond.), vol. 17, no. 431, Dec. 30, 1920, pp. 389–395, 13 figs. Works of T. Cooke & Sons, York, England.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SCRAP

Crushing Metal Chips. The Crushing of Iron, Steel and Metal Chips (Zerkleinerung der Eisen-, Stahl- und Metallspäne), R. Philipp. Betrieb, vol. 3, no. 3, Nov. 10, 1920, pp. 67–72, 20 figs. Account of a number of tests carried out by different concerns, and description of special machine said to operate on what resembles the American Hartness process, differing from this only in the forced travel of the chips. Its useful possibilities are pointed out.

SCREW MACHINES

Circular Forming Tools. Design of Circular Forming Tools, Earl H. Smiley and J. H. Davis. Machy. (N. Y.), vol. 27, no. 4, Dec. 1920, pp. 366–369, 6 figs. Calculations for designing circular forming tools having top rake.

SCREW THREADS

Milling, Side-Cutting of Hobs in. Side-Cutting of Thread-Milling Hobs, Earle Buckingham. Mech. Eng., vol. 43, no. 1, Jan. 1921, pp. 9–11 and 62, 5 figs. Mathematical study of side-cutting action of hob. Corrections in form of thread-milling hobs to produce threads sufficiently correct as to form for all practical purposes are pointed out.

SCREWS

Manufacture. The Economical Manufacture of Rolled and Cut Screws (Die wirtschaftliche Herstellung von blanken und blank bearbeiteten Schrauben), Curt Güssow. Betrieb, vol. 3, no. 4, Nov. 25, 1920, pp. 91–92, 3 figs. States that economic production of such screws and nuts is dependent upon number of pieces and resulting loss of material. Explains when work should be done on hand lathe, automatic lathe and on hot press.

SCREWS

Optical Work. Cutting and Gaging Screws. Machy. (Lond.), vol. 17, no. 428, Dec. 9, 1920, pp. 286–288, 4 figs. Method used by Taylor, Taylor & Hobson, Leicester, England. Table of tolerances for screw gages for optical work. Report of Committee of Department of Scientific and Industrial Research on Standardization of Elements of Optical Instruments.

Standards. Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, nos. 3 and 4, Nov. 10 and 25, 1920, pp. 29–40 and 49–62, 31 figs. Nov. 10: Proposals of Board of Directors for square washers for channels and I-beams. Proposed new standards for Whitworth fine thread, metric fine thread, and sizes for paper sheets; Nov. 25: Proposals for Whitworth pipe threads; lock washer; square washers for wooden joints; knob screws and nuts. Proposed standards for set screws and of screws with slotted heads, set screws; metric extra-fine thread.

SEMI-STEEL CASTINGS

Experiments. Remarks on Semi-Steel Castings (Remarque sur la fonte aciérée). Fonderie Moderne, no. 11, Nov. 1920, p. 262. Experimental study of casting temperature.

SHAFT HANGERS

Reinforced-Concrete Plants. Securing Shaft Hangers to Beams in Reinforced Concrete Plants, S. R. Stone. Belting, vol. 18, no. 1, Jan. 1921, pp. 32–38, 15 figs. Providing for expansion of departments or changes. Preplanning necessary to avoid alterations. Sleeved slits for belt drives between floors.

SHAFTS

Whirling Speeds. The Transverse Vibrations of Beams and the Whirling of Shafts Supported at Intermediate Points, E. R. Darnley. Lond., Edinburgh & Dublin Phil. Mag., vol. 41, no. 241, Jan. 1921, pp. 81–96, 1 fig. Equations giving periods of transverse vibrations of uniform beams and whirling speeds of uniform shafts, when beams or shafts are simply supported at any number of intermediate points.

Torsional Oscillations. Torsional Oscillations of Transmission Shafts (Studio sulle oscillazioni torsionali degli alberi di trasmissione), Ottorino Sesini. Associazione nazionale degli Ingegneri italiani Giornale Ufficiale, vol. 1, no. 33, Nov. 30, 1920, pp. 255–260, 7 figs. Mathematical study.

SHIP PROPULSION

Air-Propeller. Hydrogliders and Barge Propelled by Air Propellers (Hydro-glisseurs et chalands a propulsion aerienne), René Pacaud. Revue de l'Ingénieur et Index Technique, vol. 27, no. 4, Oct. 1920, pp. 257–263, 3 figs. Technical application of air propeller to barges.

Hydro-Aerial Propellers. Hydro-Aerial Propulsion for Ships (Bateaux a propulsion hydro-aérienne), A. Breton. Nature (Paris), no. 2434, Nov. 27, 1920, pp. 351–352, 5 figs. Invention of M. A. Gambin. Two propellers are placed on parallel shafts in stern of ship. About 1/4 of diameter of propellers goes under water, and propellers rotate in opposite directions. Reaction of stream of water sent against stern as well as propulsive action due to part immersed in water, propel the boat.

SHIP SALVAGE

Dredger. The Salvage of the Dredger "Silurus." Eng., vol. 111, no. 2871, Jan. 7, 1921, pp. 5–8, 11 figs. Vessel was 260 ft. by 46 ft. by 20 ft. She rested on her port bulwarks and top of port sheerstrake and with part of her funnel embedded in mud about 54 ft. below water level. Detailed account of salvage work. (To be continued.)

SHRINKAGE

Stresses in. Shrinkage Stresses in Hubs, Rings, Cranks, etc. (Strumpfspannungen in Naben, Ringen, Kurbelarmen, etc.), Karl Stösser. Der praktische Maschinen-Konstrukteur, vol. 53, no. 41–42, Oct. 14, 1920, pp. 353–359, 6 figs. Describes method for approximate determination of shrinkage stresses resulting from the hot and cold fitting of crank arms, hubs, rings, etc., to shafts; the stresses are shown graphically and an example is given.

SPRINGS

Helical. Chart and Simplified Formulæ for Helical Springs of Tempered Steel. Machy. (Lond.), vol. 17, no. 429, Dec. 16, 1920, pp. 318–319, 1 fig. Chart for determining carrying capacity, deflection and dimensions of tempered steel helical springs, tension or compression.

STANDARDIZATION

Machine Tools. The Effect of Standardization on Lathe Centers (Wirkung der Normung von Drehbankspitzen), H. Plumpe. Betrieb, vol. 3, no. 4, Nov. 25, 1920, pp. 94–97, 3 figs. An example is cited showing advantages of a comprehensive standardization of the parts of machine tools which must be frequently renewed.

System of Fit Allowances. A System of Fit Allowances, Sydney B. Austin. Machy. (N. Y.), vol. 27, no. 5, Jan. 1921, pp. 452–454, 3 figs. Curves showing relation of allowances for fits to various diameters. Comparison of theoretical curves with B. & S. system of fit allowances and with Newall Engineering Co.'s system of fits.

STEAM-ELECTRIC PLANTS

Design. Tendencies in the Design of Power Stations, Peter Junkersfeld. Elec. World, vol. 77, no. 1, Jan. 1, 1921, pp. 5–7, 5 figs. Economies resulting from skillful arrangement of station and layout of equipment and operating tendencies in boiler and turbine rooms. Survey of principal achievements in 1920.

France. The Electric Plant of the French State Railways at Nanterre, Seine (L'usine électrique des chemins de fer de l'etat à Nanterre (Seine), Lucien Pahin. Industrie électrique, vol. 29, no. 684, Dec. 25, 1920, pp. 466–470, 2 figs. Turbo generators of 5500 kw. each generating 3-phase current at 50,250 volts.

Signal Indicators. Adapting Signal Indicators to Power Plant Use, H. P. Sparkes. Elec. World, vol. 76, no. 26, Dec. 25, 1920, pp. 1251–1252, 2 figs. Apparatus consists of two synchronous motors connected so that when rotor of one transmitter, is placed in certain position rotor of other, indicator will be in exact synchronism and will thus indicate position at which transmitter is set. Apparatus was constructed during war for use on board U. S. Navy vessels and is being applied to transmitting signals from switchboard to boiler room in electric plants.

280,000-Kw. Building 280,000-Kw. Plant in New York City. Elec. World, vol. 77, no. 3, Jan. 15, 1921, pp. 140, 1 fig. Generator room adjacent to river to eliminate suction tunnels. Four units of 35,000 kw. each to be installed at outset.

STEAM ENGINES

A.S.M.E. Test Codes. Power Test Codes. Mech. Eng., vol. 43, no. 1, Jan. 1921, pp. 32–36, 1 fig. Preliminary draft of test code for reciprocating steam engines, formulated by Am. Soc. Mech. Engr. Test Code Committee.

STEAM TURBINES

Lubrication. The Lubrication of Steam Turbines (La lubrification et le système de graissage des turbines à vapeur), C. P. Roux. Revue générale de l'Électricité, vol. 8, no. 25, Dec. 18, 1920, pp. 870–872, 1 fig. Suggested specifications for oils and greases.

Small Machines. Small Steam Turbines, W. J. A. London. Proc. Engrs. Soc. Western Pennsylvania, vol. 36, no. 8, Nov. 1920, pp. 539–564 and (discussion) pp. 565–573, 15 figs. Study of reliability, simplicity, cost and efficiency. Turbines considered are those having output of from 5 to 300 hp.

STEEL

Defects. Defects Arising in Steel During Fabrication, Austin B. Wilson. Chem. & Metallurgical Eng., vol. 23, no. 25, Dec. 22, 1920, pp. 1209–1213, 24 figs. Microscopic appearances caused by surface defects, cold-working, overheating, and burning. Nuclei of fatigue fractures are associated with phosphorus bands. Photographs of changes in structure during annealing of steel castings are also given.

Magnet. On K. S. Magnet Steel, Kotaro Honda and Shozo Saito. Physical Rev., vol. 16, no. 6, Dec. 1920, pp. 495–500, 7 figs. Also Elecn., vol. 85, no. 2222, Dec. 17, 1920, pp. 706–708, 7 figs. Alloy developed in research work at Tokyo University. Composition is cobalt 30 to 40 per cent, tungsten, 5 to 9 per cent, and chromium 1 1/2 to 3 per cent. Tempering is best effected by heating to 950 deg. cent. and quenching in heavy oil. Measurements of residual magnetism for specimens of different composition gave values from 920 to 620 C. G. S. units; coercive force for same specimens ranged from 226 to 257 gauss.

Manganese. See MANGANESE STEEL.

Nickel. See NICKEL STEEL.

Nickel-Chromium. See NICKEL-CHROMIUM STEEL.

Research. Research on Steel Conducted in Germany During the War (Etudes faites en Allemagne durant la guerre, sur la connaissance des aciers), Gaston Paris. Chaleur et Industrie, no. 7, Oct. 1920, pp. 408–418, 10 figs. Influence of chemical composition and mechanical properties. Graphs showing properties of specimens subjected to different treatments.

Shock Values after Heat Treatment. Comparative Shock Values of Steel after Varied Heat Treatments, F. C. Langenberg and J. F. Fetterely. Army Ordnance, vol. 1, no. 2, Sept.-Oct. 1920, pp. 99–100. Results of tests.

Structural. See STRUCTURAL STEEL.

Welding. The Welding of Steel in Relation to the Occurrence of Pipe, Blowholes and Segregates in Ingots, Harry Brearley. Iron & Coal Trades Rev., vol. 101, no. 2755, Dec. 17, 1920, pp. 821–822. Experimental studies. Paper read before Cleveland Instn. Engrs.

Woody Fractures. The Woody Fracture in Steel (Ueber den Holzfaserbruch im Stahl), E. H. Schulz and J. Goebel. Stahl u. Eisen, vol. 40, no. 44, Nov. 4, 1920, pp. 1479–1485, 21 figs. With the aid of sample pieces the different formations of woody fractures in steel are discussed and it is shown that the causes therefor can be of very different origin. The two main groups of such fractures are described.

STEEL CASTINGS

Annealing. Anneal Steel with Pulverized Coal, C. H. Gale. Foundry, vol. 49, no. 1, Jan. 1, 1921, p. 29, 4 figs. Results of annealing steel castings with pulverized coal. Paper read before Am. Foundrymen's Assn.

Strength. Steel Castings of High Strength and Toughness—I, Frederico Giolitti. Chem. & Metallurgical Eng., vol. 24, no. 3, Jan. 19, 1921, pp. 113–118, 22 figs. Data on improvement to be expected after properly heat-treating steel castings, with illustrative tests on strong, tough castings which have replaced forgings on gun mounts. Advance copy of chapter of forthcoming book entitled "Heat Treatment of Soft and Medium Steels."

STEEL MANUFACTURE

Electric-Furnace. Heat Modifies Acid Furnace Reaction, James W. Galvin and Charles N. Ring. Foundry, vol. 49, no. 2, Jan. 15, 1921, pp. 72–74. Electric furnace develops such high temperatures that chemical affinities in still are reversed. Steep sides with deep bath increase melting efficiency and compact charge is advocated.

STEEL WORKS

Coal Consumption. Coal Consumption in Steel Metallurgy (La consommation de charbon dans la grosse métallurgie). Génie Civil, vol. 77, no. 25, Dec. 18, 1920, pp. 499–503. Records of coal consumption of steel works producing 300,000 tons per year.

Two-Shift vs. Three-Shift System. The Three-Shift System in the Steel Industry, Horace B. Drury. Indus. Management, vol. 61, no. 1, Jan. 1, 1921, pp. 63–68, 5 figs. Survey of adoption of three-shift system in European countries, and account of its operation in about 20 American plants where it has been adopted. Paper read before Taylor Society.

STREET RAILWAYS

Brakes. See BRAKES, Street-Car.

STRESSES

Determining by Polarized Light. Determining Stresses by Polarized Light, George Weed Hall and Arthur L. Kimball, Jr. Sci. Am. Monthly, vol. 3, no. 1, Jan. 1921, pp. 49–53, 7 figs. Apparatus which permits visualization of stress distribution.

Stress Determination by Means of the Coker Photo-Elastic Method, A. L. Kimball, Jr. Gen. Elec. Rev., vol. 24, no. 1, Jan. 1921, pp. 73–81, 13 figs. Optical system for determining stress by polarized light.

Safe Loads. Chart for Determining Safe Loads, J. B. Conway. Am. Mach., vol. 53, no. 27, Dec. 30, 1920, pp. 1241–1242. Chart for determining safe load for parts in tension, compression and shear where part does not exceed in length, ten times its diameter. Chart is based upon formula for determining safe load in different materials.

Study of. Plane Stress and Plane Strain in Bipolar Co-Ordinates, G. B. Jeffery. Philosophical Trans. Royal Soc. Lond., vol. 221, series A, Aug. 11, 1920, pp. 265–293, 4 figs. Mathematical study.

Theories. Comparison of the Extension and Shearing Stress Theories (Beitrag zum Vergleich der Dehnungs- und Schubspannungstheorie), H. Boute.

STOKER MANUFACTURERS ASSOCIATION SMA

TRADE MARK Rx REGISTERED

Meeting Steam Demands *in the* Rubber Industry

Steam demands in the tire and rubber factories have grown enormously with the rapid expansion of this industry. The use of steam in the manufacturing process as well as for power makes the economical generation of steam a highly important factor. Every additional per cent of increase in efficiency and above all reliable, continuous operation pays big dividends where steam making plays so important a part.

RILEY UNDERFEED STOKERS

are finding favor in the rubber industry because they can operate at 200% to 300% of rating—not for a short time only, but continuously and consistently. This means fewer boilers are required with corresponding decrease in investment, maintenance and operating expenses.

Rubber Companies having Riley Underfeed Stokers installed or on order include:

Goodyear Tire & Rubber Co.****
Hood Rubber Co.***
Morgan & Wright Co.***
B. F. Goodrich Co.**
Firestone Tire & Rubber Co.
Kelly-Springfield Tire Co.
Hartford Rubber Co.
Dunlop-America, Ltd.
Mechanical Rubber Co.

*Indicates number of orders

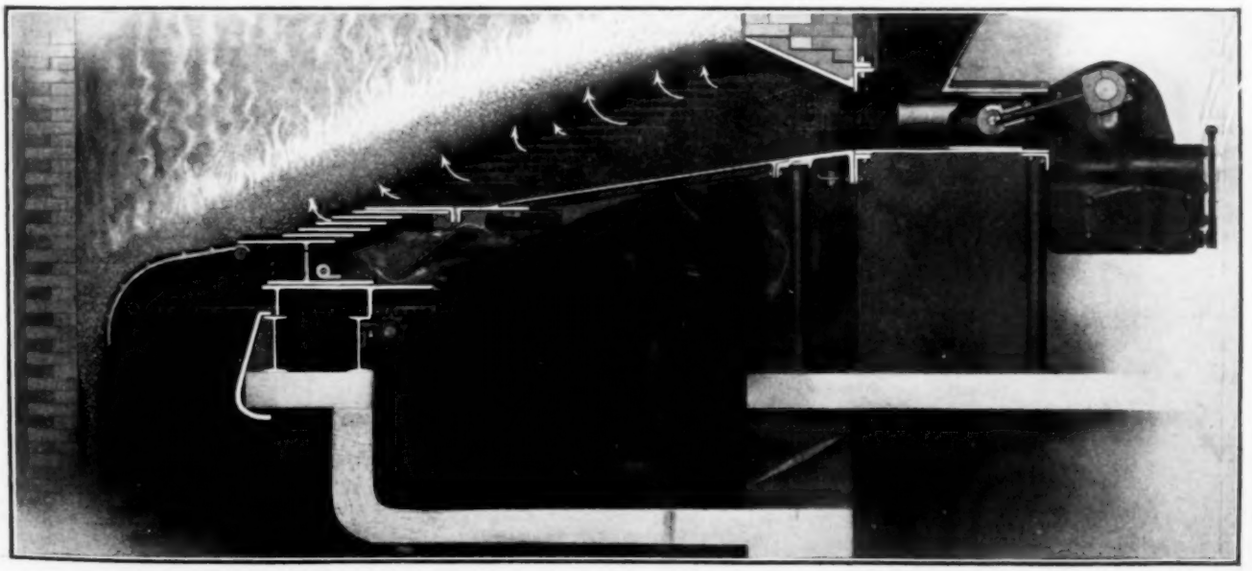
Our catalog explains the *live grate surface* and the *continuous automatic ash discharge*—two essentials for high efficiency and capacity—send for it.

"A type to meet every stoker need"

SANFORD RILEY STOKER CO.
WORCESTER, MASS.
Makers of
RILEY STOKERS
BOSTON NEW YORK CINCINNATI PHILADELPHIA CHICAGO PITTSBURGH ST. PAUL

MURPHY IRON WORKS
DETROIT, MICH.
Makers of
MURPHY FURNACES
BUFFALO CLEVELAND DENVER

The Sanford Riley Stoker Co. is now prepared to equip new Riley Stokers with coal agitators licensed under the Negus-Tiffany patents.



ENGINEERING INDEX (Continued)

Zeit. des Vereines deutscher Ingenieure, vol. 64, no. 51, Dec. 18, 1920, pp. 1071–1073, 7 figs. The sudden yielding of the test pieces of ordinary soft low-carbon steel at upper yield point is used to demonstrate superiority of the formula for the simultaneous tensile and twisting stress over analogous formulas. Results of experiments are said to be particularly valuable due to fact that according to shearing stress theory, cross-sections would be greater, whereas the extension theory in this respect gives not only more correct values of stress, but also smaller construction weights.

STRUCTURAL STEEL

Specifications. Belgian Standard Specification for Structural Steelwork. Eng. News-Rec., vol. 86, no. 2, Jan. 13, 1921, pp. 71–72. Specifications for design and fabrication of steelwork for buildings and miscellaneous steel structures adopted by Belgian Standards Association.

T

TARGET

Towed, for Battleships. See WARSHIPS, Towing Target.

TERMINALS, RAILWAY

Management. Utilizing Motive Power on the Lines of the Delaware & Hudson. Ry. Rev., vol. 67, no. 26, Dec. 25, 1920, pp. 961–967. Methods of terminal management.

Operation. Railway Terminals and Terminal Yards. William Barclay Parsons. Mech. Eng., vol. 43, no. 1, Jan. 1921, pp. 21 and 62. Cost of terminal operation and possibilities of reducing it.

TESTS AND TESTING

Flexure. An Apparatus for Delicate Flexure Tests and Some Results of Such Tests, W. J. Francke. Am. Mach., vol. 54, no. 2, Jan. 13, 1921, pp. 48–52, 5 figs. Apparatus designed to test thin, tempered strip-steel shims used in flexible couplings. Paper read before Am. Soc. for Testing Matls.

Million-Pound Machine. Million Pound Testing Machine for Forest Products Laboratory, L. J. Markwardt. Eng. News-Rec. vol. 86, no. 1, Jan. 6, 1921, pp. 31–32, 2 figs. Machine is of two-screw type and has overall height of 45 ft., including superstructure above weighing platform, which will enable it to accommodate columns up to 30 ft. or tension members up to 27 ft. in length.

Motion Pictures, Use in. Motion Pictures in Physical Testing Laboratory, H. J. French. Chem. & Metallurgical Eng., vol. 24, no. 3, Jan. 19, 1921, p. 131, 4 figs. Application of moving-picture camera to testing of materials.

Notched-Bar Tests. Experimental Study of Notched-Bar Impact Tests (Étude expérimentale sur les essais au choc des barreaux entaillés), M. André Cornu-Thénard. Revue de Métallurgie, vol. 17, no. 10, Oct. 1920, pp. 648–667, 6 figs. Case of extra-mild steel crystallized in large drains. Photomicrographs. (Concluded.)

Photo-Elastic Testing. Photo-Elasticity for Engineers—III, E. G. Coker. Gen. Elec. Rev., vol. 24, no. 1, Jan. 1921, pp. 82–88, 10 figs. Discussion of photo-elastic investigation of testing materials in tension. It is shown that if enlarged ends of test bar are connected with parallel part by arcs of circle stress near joint of arc with parallel portion is somewhat greater than that in parallel portion.

THERMODYNAMICS

Carnot-Clausius Principle. Application of Carnot-Clausius Principle to Impact Waves in Elastic Solids (Application du principe de Carnot-Clausius aux ondes de choc des solides élastiques), E. Jouguet. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 19, Nov. 8, 1920, pp. 904–907. Conditions which Carnot-Clausius principle imposes on impact waves of solids when these waves originate discontinuities of not too great an amplitude.

TIDAL POWER

Development. Tidal Power Development, A. H. Gibson. Eng., vol. 110, nos. 2867–2868, Dec. 10–17, 1920, pp. 778–780, 6 figs., and 793–795, 11 figs. Outline of more promising schemes which have been suggested and patented.

Utilization of. Blue Coal (La houille bleue), R. Gouedard. Vie technique & industrielle, vol. 2, no. 13, Oct. 1920, pp. 17–24, 8 figs. Scheme for utilization of tidal power by means of low-head turbines. (Concluded.)

Report on Tidal Power. Engr., vol. 130, no. 3390, Dec. 17, 1920, pp. 614–615. Third interim report of Water Power Resources Committee appointed by British Board of Trade. Discussion of question of tidal power, with reference to project for utilizing 500,000 hp. of tidal energy in estuary of Severn River.

Studies in Tidal Power, Norman Davey. Engr., vol. 130, nos. 3388–3392, Dec. 3, 10, 17, 24 and 31, 1920, pp. 556–558, 578–580, 603–604, 634–636, and 652–654, 25 figs. Dec. 3: Classification and study of systems for conservation and use of tidal power; Dec. 10: Quantitative estimate of tide power cycles; Dec. 17: Analysis made of gross power available from tides under various systems of working, and change in this power factor examined under variations in tidal range; Dec. 24: Survey of tidal power available in England; and Dec. 31: Minimum constant hp. available from tides in England and Scotland is computed at 489,000 hp.; this value rising during springs to 1,555,000 hp. Gross totals of intermittent power are, minimum during neaps, 3,550,000 hp. and during springs, 15,300,000 hp.

Tidal Hydro-Electric Scheme for the Severn. Engr., vol. 130, no. 3388, Dec. 3, 1920, pp. 562–563, 1 fig. Discussion of scheme formulated by Civil Engineering Department of Ministry of Transport.

Utilization of Tidal Power and Energy of Wave Impact (Utilisation de la force des marées et du choc des vagues de la mer), H. Parenty and G. Vandamme. Comptes rendus des Séances de l'Academie des Sciences, vol. 171, no. 19, Nov. 8, 1920, pp. 896–898, 2 figs. Cement structure containing parallel cells along coastal region subjected to ebb and flow. Impact of water in cells compresses air in tanks behind cement structure.

Utilization of Tidal Power on the Coast of France (De l'utilisation des courants de marée sur les côtes de France), M. La Porte. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 24, Dec. 13, 1920, pp. 1205–1207. Study of points where utilization is most practicable.

TIME STUDY

Machining Operations. Determination of the Time Required for Machining Operations (Bestimmung der Arbeitszeiten für die Vorkalkulation im Maschinenbau), H. Eipel. Motorwagen, vol. 23, nos. 22 and 23, Aug. 10 and 20, 1920, pp. 409–413, 23 figs. 4 on 2 supp. plates. Calculating charts for determining time employed in turning and grinding, drilling and cutting thread, planing and slotting and milling and sawing.

Siemens-Schuckert Works. Application of Time Study in Large Industrial Plants (Anwendung der Zeitstudie im Grossbetrieb), C. W. Drescher. Betrieb, vol. 3, no. 5, Dec. 10, 1920, pp. 128–135, 7 figs. Describes practice and experiences in the electric motor plant of the Siemens-Schuckert Works.

TRACTOR ENGINES

Manufacture. Methods in a Tractor Engine Plant. Machy. (N. Y.), vol. 27, no. 5, Jan. 1921, pp. 424–427, 9 figs. Special machinery and unusual equipments for standard machine tools.

TRACTORS

Tests. More Results of Tractor Tests at Nebraska. Automotive Industries, vol. 43, no. 27, Dec. 30, 1920, pp. 1306–1308. Of Sixty-six tractors tested, eight have increased their rated engine speed, six lowered their horsepower rating, fourteen changed some item of equipment and three have withdrawn.

TRANSPORTATION

Coal Industry. The Transportation Problem in the Coal Industry, A. G. Gutheim. Ry. Age, vol. 69, no. 27, Dec. 31, 1920, pp. 1149–1152. Remarks of experience during war period.

Conditions in U. S. The New Era of Railroad Transportation in America, Lewis J. Spence. Ry. Age, vol. 69, no. 27, Dec. 31, 1920, pp. 1153–1154. Importance, both to carriers and shippers, of maintaining spirit of friendly coöperation. Paper read before National Industrial Traffic League.

Inland Waterways. Some Inland Waterway Transportation Problems, V. E. Lacy. Jl. Soc., Automotive Engrs., vol. 8, no. 1, Jan. 1921, pp. 59–62, 5 figs. Motive power for canal traction.

Railways. How the Need for More Motive Power Will be Met. Ry. Age, vol. 70, no. 1, Jan. 7, 1921, pp. 43–46, 3 figs. New locomotives, remodeled old locomotives and improved operation of all locomotives imperative.

Railroad Transportation, Daniel E. Willard. Mech. Eng., vol. 43, no. 1, Jan. 1921, pp. 17–18. Fundamentals for developing a complete and well-articulated national transportation system.

Repair Shop and Enginehouse Equipment Needs. Ry. Age, vol. 70, no. 1, Jan. 7, 1921, pp. 50–52. Large numbers of unserviceable locomotives and cars furnish strong argument for better facilities.

The Next Step Toward Preventing Depressions. Ry. Age, vol. 70, no. 1, Jan. 7, 1921, pp. 33–38, 11 figs. Stability of railway purchases offered as remedy by railway business association committee.

What Additions to Physical Property are Necessary? Ry. Age, vol. 70, no. 1, Jan. 7, 1921, pp. 39–43, 3 figs. Little increase in traffic possible without betterments in terminals and other facilities.

V

VALVES

Globe. Use and Abuse of Globe Valves. Ry. Rev., vol. 25, no. 67, Dec. 18, 1920, pp. 946–948, 2 figs. Recommends that railroads select one make of valve as standard for all their uses and maintain special globe valve repair and testing service.

Power Plants. Valves for Inconvenient Locations, Charles L. Hubbard. Power Plant Eng., vol. 25, no. 2, Jan. 15, 1921, pp. 111–115, 19 figs. Methods of reaching and operating in power plants.

VENTILATION

Ventilators. Recent Tests on Automatic Ventilators, A. J. Mack. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 26, no. 9, Dec. 1920, pp. 849–853, 3 figs. Tests conducted by Engineering Experiment Station of Kansas State Agricultural College upon different types of ventilators. Effectiveness of different types when operated under varying conditions was studied, and comparative tests were made on syphon ventilator and those types not intended to produce any syphoning action.

VIBRATIONS

Study. The Photo-Radiograph, A. C. Banfield. Sci. Am. Monthly, vol. 3, no. 1, Jan. 1921, pp. 44–45, 6 figs. Instrument for study of vibrations.

W

WAGES

High. The Cost of Labor and the Labor-Cost, Elmer W. Leach. Am. Mach., vol. 53, no. 26, Dec. 23, 1920, pp. 1188–1189. Suggests that wages be kept up by reducing labor cost, that is increasing production per man.

WARSHIPS

Towing Target. The Metal Arc Welded Battle Towing Target Built at the Norfolk Navy Yard, James W. Owens and H. G. Knox. Welding Engr., vol. 5, no. 12, Dec. 1920, pp. 23–28. Constructed for experimental purposes by Bur. of Construction and Repair of U. S. Navy.

WASTE HEAT

Utilization. The Utilization of Exhaust Heat in Modern Factories (Abfallwärmeverwertung in modernen Betrieben), Ernst Blau. Der praktische Maschinen-Konstrukteur, vol. 53, nos. 37–38 and 39, Sept. 16 and 30, 1920, pp. 321–328 and 343–352, 21 figs. Details and illustrations of a number of recent German patents and devices for the utilization of waste heat from furnace plants, gas and Diesel engines, and from steam engines.

WASTE RECLAMATION

Industry. Utilization of Waste in Trade and Industry (Abfallwirtschaft in Industrie und Gewerbe) Betrieb, vol. 3, no. 4, Nov. 25, 1920, pp. 29–31. Gives working program proposed by the Bureau for handling the waste problem which was organized by the Committee for Economic Production (AWF) in conjunction with official authorities.

WATER HAMMER

Penstock. Water Hammer in Penstocks of High-Reaction Turbines (Sur le coup de bélier dans les conduites forcées alimentant des turbines à forte réaction), M. de Sparre. Comptes rendus des Séances de l' Académie des Sciences, vol. 171, no. 18, Nov. 2, 1920, pp. 833–835. Modifications to be made in general formula for maximum water hammer in a conduit to make it applicable to case of penstocks.

Pipe Lines. Water Hammer in Pipe Lines, W. F. Durand. Eng. News-Rec., vol. 85, no. 26, Dec. 23, 1920, pp. 1212–1216, 6 figs. Studies extended to include effects of imperfect reflection at discharge end, friction, non-uniform change of valve opening and imperfect action of discharge opening as nozzle.

WELDING

Autogenous. See AUTOGENOUS WELDING.

Electric, Arc. See ELECTRIC WELDING, ARC.

Oxy-Acetylene. See OXY-ACETYLENE WELDING.

WELDS

Testing. The Testing of Welds in Steel Plates, S. W. Miller. Ry. Elec. Engr., vol. 12, no. 1, Jan. 1921, pp. 49–52, 9 figs. Conditions which affect quality of welds; simple bend test and etching of sections recommended. Paper read before Chicago Section, Am. Welding Soc.

WIND TUNNELS

Göttingen. German Wind Tunnels and Apparatus, Edward P. Warner. Aeronautics, vol. 19, no. 376, Dec. 30, 1920, pp. 468–469, 2 figs. Description of Göttingen wind tunnels. (To be continued.)

New Method of Testing Models. New Method of Testing Modèls in Wind Tunnels (Nouvelle méthode d'essai de modeles en soufflerie aérodynamiques), W. Margoulis. Comptes rendus des Séances de l'Académie des Sciences vol. 171, no. 31, Nov. 22, 1920, pp. 997–999. Also Aeronautics, vol. 19, no. 373, Dec. 9, 1920, pp. 412–413, 1 fig. Utilization of carbonic acid instead of air, at pressures and temperatures which are suitable and generally very different from those of surrounding atmosphere.

WOODWORKING MACHINES

Dovetailing Cutters. Dovetailing Machine Cutter Standards (Zinkenfräsernormalien), Otto Wenzel. Werkstattstechnik, vol. 14, no. 20, Oct. 15, 1920, pp. 535–536, 21 figs. Describes standard spindle cutter for use in dovetailing with a pitch of 1 in. or 25 mm. which are adapted to approximately uniform measurements in inches and millimeters.

Dust Collection. Efficient Dust-Collecting Systems. Wood-Worker, vol. 39, no. 10, Dec. 1920, pp. 30–32, 2 figs. Layout of dust-collecting systems in table factory.

WOMEN WORKERS

Adaptability. The New Place of Women in Industry—IV, Ida M. Tarbell. Indus. Management, vol. 61, no. 1, Jan. 1, 1921, pp. 51–58. Records of employment of women at International Harvester Co.

Telephone Industry. Women in Industry. Monthly Labor Rev., vol. 11, no. 6, Dec. 1920, pp. 117–125. Statistics of labor turnover and length of service in telephone industry in New York State.